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STUDYING THE EFFECT OF ENVIRONMENT UPON THE DEVELOPMENT OF PARASITIC DISEASES AND SELECTING FOR DISEASE RESISTANCE PRESENTS PROBLEMS IN CO-OPERATION IN RESEARCH[1]

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INTRODUCTION

The parasite rightly is considered the primary cause of the parasitic disease in plants. Yet the progress of investigation is making more evident each year the conclusion that in practically all cases the serious development of the disease is conditioned upon certain environmental factors. This requires not only the recognition of the parasitic or causal factor, but also the definition of these conditioning factors of the environment and their influence upon both host and parasite in the occurrence and severity of disease development as well as the expression of resistance to the disease in the host. In other words, it is not sufficient to detect the parasite and prove its pathogenicity; this must be followed by the analysis of the influence of environmental conditions upon the physiological processes within host and parasite and their relation to both the development of the disease and the expression of resistance to disease. In general, the whole problem of plant adaptation must be studied in relation to economical crop production.

The solution of such problems in the biological sciences is dependent upon suitable analytical methods. Biological research is founded largely on the exact sciences of physics and chemistry. The problem of applying the principles of these sciences and the exact methods of defining them to the analysis of living complexes and their reaction to a changing environment has been the biologist's greatest problem. In other words, to analyze the external conditions and internal reactions of the plant and the influence of these upon plant functions in terms of physical laws and chemical reactions has necessitated the development of a dynamic, comparative technique based upon the sciences of mathematics, physics and chemistry. Unfortunately, this has been left largely in the hands of the biologist inadequately trained in the basic sciences rather than to the sympathetic co-operation of men who are trained in these exact sciences and who have an appreciation of the lability of biological substances. In laboratories where these two groups, the so-called pure and applied scientists, are co-operating much progress has been made in the development and refinement of biological methods and technique. If space permitted, several laboratories could be listed where co-operation of

[1] Invitation paper delivered before the Canadian Phytopathological Society, Guelph, Ontario, June 23, 1931.

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this type is giving rise to new methods mathematically correct and physically and chemically sound and yet adaptable to the analyses of biological problems. not a new definition of the environmental complex as Sachs, in presenting

The Plant Environment

The plant can no longer be considered in terms of its external environment alone. In general, the effects of such ecological factors as temperature, light, fertility, moisture, etc., have been studied in terms of their gross effect upon plant development and yield. These researches have demonstrated the general flexibility or lack of flexibility of the plant population to adapt itself to the environmental complex as a whole either in terms of its vegetative development or of its reproductive capacity. It is necessary to consider still another phase of the environment if the vegetative development and reproductive capacity are to be interpreted in terms of physiological processes. For the sake of convenience, this second phase of the complex may be termed the internal environment in contrast to the external factors of the plant environment. Thus temperature, moisture, light, fertility, etc., influence within certain limits, the physiological processes, the planes of metabolism, within the plant; these changes in turn influence the reserve substances and specific compounds available and their relative balances within the tissues and cells; and these new reactions modify or change the trend of plant functions either immediately or later in the cycle of development, in some instances even modifying temporarily the expression of genetic characters, or in extreme cases inducing segregations or mutations. This, however, is not a new definition of the environmental complex as Sachs in presenting his "Stoff theories", and Sorauer, in defining "predisposition", both suggested this approach to the problem. More recently, Kidd and West, and Kraus and his students, have shown the importance of this approach to the problems in plant science. Generally, however, the physiological processes have been studied independently with less attention given to reversible metabolic reactions or balances and their effect upon the entire labile complex comprising the so-called internal environment and its influence upon plant function and expression of characters. The full appreciation of this complex of reversible physical and chemical reactions within the plant tissues, each process changing in relation to the other and all influenced directly or indirectly by the external environment, emphasizes the importance of analyzing not only the external environment but this internal complex as well in the study of any phase of plant disease development or expression of disease resistance.

Methods Used in Producing the Environmental Complex

More exact methods are needed in analyzing the influence of the environment upon disease development and the expression of disease resistance. From the standpoint of the pathologist, the first essential is a suitable environment for the epidemic expression of the disease, whether considered from the viewpoint of the disease-contributing factors, the development of the disease, selecting for disease resistance, or studying the nature of resistance to disease. Likewise, from the standpoint of the pathologist, geneticist, physiologist and biochemist alike, the environment must be under sufficient control so that the experiment can be repeated. And finally, plant material showing sufficient contrast in reaction must be selected and stabilized to

facilitate the analysis of local and regional environmental influences by comparison with these standard or check plant indicators. In fact, the comparative method of analysis becomes essential in analyzing every phase of the plant's reaction to the environmental complex. Differences are found only by suitable comparisons with standards. In disease studies, susceptible and resistant controls, and in drought resistance tests, non-tolerant and tolerant checks must be distributed not only in the local planting but the same standards must be used in the regional tests as well.

Controlled environments are necessary but must be supplemented by field and regional studies. Control chambers and greenhouses equipped with control apparatus are essential for the study of the problems, especially in analysing and stabilizing plant material to be used as controls or standards, and later in the detailed study of the physiological changes within the plant tissues. No study of the plant environment is complete, however, without the comparative study of the plant or the development of the disease under field and regional conditions. The practical application of the problem is contingent upon regional adaptation of the plant, whether dealing with problems of disease development, disease resistance, plant yield, or quality of the product.

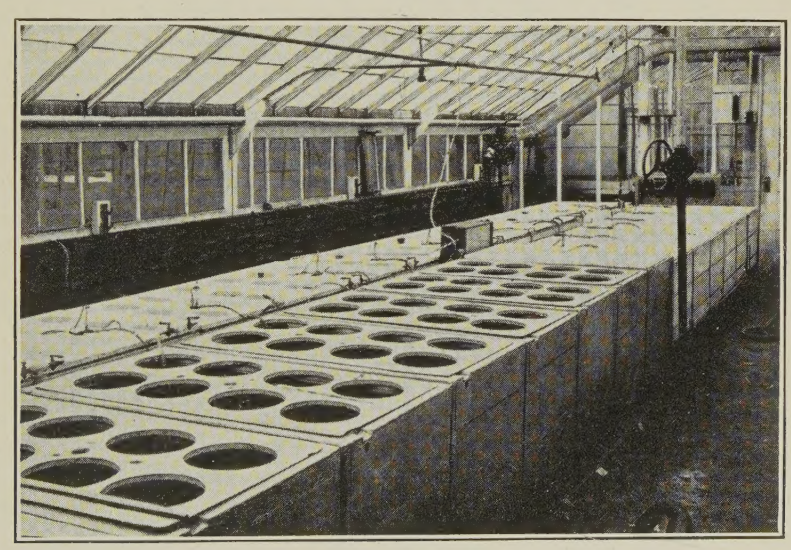

Figure 1. Showing a battery of Wisconsin soil temperature tanks used for soil temperature control. The tank consists of a simple, inexpensive water bath in which the soil containers are suspended for temperature control of the soil. A small stream of cold water running into the tank lowers the temperature below that desired in the experiment. A thermostated electrical heater raises the bath to the desired temperature.

Elaborate equipment is unnecessary in the study of the influence of environment upon plant development. A relatively small investment is sufficient to initiate research of this type. The Wisconsin soil temperature tank is an example of an inexpensive, thermostatically controlled water bath, in which the soil containers are suspended to maintain the soil environment at a constant or fluctuating temperature (Figure 1). The plants are grown in

these containers in this simple water bath with proper attention given to holding the other factors of the environmental complex near the optimum requirement for the particular experiment. This does not mean, for example, that a given moisture content of the soil, plane of fertility, or level of light intensity or period of light duration is adequate over the entire range of soil temperatures used. These other factors must be modified or balanced to meet the changed physiological demands of the plants at the different soil temperatures. This can be illustrated by results obtained with wheat plants

Figure 2. Showing the influence of soil temperature upon the development and heading of Turkey wheat. Plants held at temperatures of 16°C. and below developed large root systems and produced well filled heads. The plants grown at the high temperatures tillered excessively and remained in the vegetative condition. Chemical analyses showed the plants grown at 16°C. and below were high in carbohydrates and low in nitrogen. The plants grown at temperatures of 20°C. and above decreased rapidly in total carbohydrates and were high in nitrogen. The potash and phosphorus requirements of the low temperature plants were very high.

grown at different soil temperatures. The wheat plants growing at 12-16°C. soon produce an excess of carbohydrate reserves and reach metabolic balances which require much more potassium and phosphorus in their development than those at 24-28°C. (Figure 2). Where the same plane of fertility is maintained throughout the temperature series, the influence of temperature is soon modified at the low temperatures by a deficiency of these soil elements. Or again, the light requirements at the low soil temperatures differ distinctly from these at the high temperatures where the carbohydrate reserves are respired much more rapidly than at the lower temperatures. While this

light relationship holds true for wheat, it is of less importance with corn, a more efficient organism at the higher temperatures with consequently a much lower respiration coefficient. Therefore it is necessary to understand the plant and appreciate its requirements before control equipment of any type can be used successfully.

The control chambers have a place in the detailed study of environment. The cost of control chambers is usually higher than temperature tanks and is only advisable where exact control of temperature, humidity and air conditions is necessary in the details of the study or where special equipment for a specific problem is needed, such as Maximov is using in testing for drought resistance or Holbert is operating in studying cold resistance.

Control greenhouses are the most economical and efficient equipment for environmental studies. Larger populations can be grown at less expense than in either soil temperature tanks or control chambers. Thermostated heat control with a ventilation system operating on a thermostat set one or more degrees higher than the former thermostat, gives excellent temperature control during the periods of low outside temperatures. Likewise, humidity can be controlled within relatively close range by using a mechanical humidifier similar to the Bahnson type or by passing the air through a tempered water spray before distributing it into the greenhouse.

Field equipment of simple design is essential in field studies especially in studying disease development and selecting for disease resistance. Field experiments in disease studies are frequently indefinite due to environmental conditions unfavourable for the development of the disease. Where equipment can be developed to insure maximum infection and disease development or to secure differentation in disease manifestation much time and uncertainty can be eliminated. Frequently this can be accomplished by changing the location or date of planting. The use of protective coverings or light weight tents has given excellent results in the mosaic studies for controlling leaf hopper and other insect infestations. Large tents have been used the past two years to secure conditions for epidemic development of the cereal scab disease caused by *Fusarium* and *Gibberella* species. The cost of such equipment is low in proportion to the investment of time and insures maximum disease development. Such equipment could be used to good advantage in investigations with rusts and other aerial parasites where humidity, light intensity, and other factors must be controlled to insure disease development.

Experiments under controlled conditions must be correlated with those under field conditions. After satisfactory controls or check strains have been selected and stabilized, plantings under different regional conditions and at different periods are essential to evaluate the crop or the disease development in terms of regional adaptation and to determine variation in pathogenicity in the parasite causing the disease. Likewise, the field experiments are essential to study the competitive relationship between various parasitic organisms in terms of disease development and to select for resistance to more than one disease in breeding for disease resistance.

The field studies are successful only when supported by administrative policies and sufficient funds for regional testing of material. In the United States this phase of most of the research projects in both the animal and

plant studies is developed by the scientists in the United States Department of Agriculture, with the state experiment stations directing their attention to the more local or state problems. This division of responsibility works ideally where there is proper correlation and co-operation between the two groups of workers. Frequently, however, administrative policies, especially in the states, have set up boundaries that have no relationship to regional areas and have thus greatly hindered the progress in research of this type. In most instances, the administrators must share their full responsibility in the inefficient expenditure of funds devoted to research through lack of federal and interstate co-operation and co-ordination. At present there is no place where this responsibility falls more directly upon the Deans and Directors of our State Agricultural Experiment Stations than in the present administration of the problems of crop improvement. Adequate funds must be available and administrative policies modified before expensive duplication without co-ordination can be replaced by co-operation between states and provinces interested in similar research projects in crop improvement.

Progress Report on Problems being Solved by Co-operative Research

Two examples of results obtained through co-ordinated research[3] are given to illustrate the previous discussion. The first example includes the analysis of the effect of environment upon the complex of disease development and the correlation of this with the metabolism and physiological balances within the host plants, wheat and corn seedlings, and the parasite, *Gibberella saubinetii* (Mont.) Sacc., and the nature of resistance to the seedling blight in these two hosts. The second shows the influence of environment during the maturation period upon the subsequent development of the corn plant.

Seedling Blight and the Nature of Resistance

The seedling blight is particularly well adapted to the study of disease development correlated with host metabolism. The cortical rot produced in the progress of the disease is easily followed as it advances in the seedling tissues and is produced by the same parasite in the two hosts, corn and wheat. The two hosts also have widely different growth requirements, especially in relation to temperature (Figure 3). Wheat is essentially a low temperature plant, especially during the seedling stage, and develops best in a cool climate. Corn is a high temperature plant and develops best in a warm climate.

There is a direct correlation between temperature and disease reaction in the two hosts. Wheat seedlings blight at the high temperatures and are resistant at the low temperatures when grown under favorable light, moisture and other conditions. In contrast, corn seedlings blight at the low temperatures and are resistant at the high temperatures unless other factors of the environment are unfavorable. Modification of other factors of the environment to the extent that they cause an unbalanced condition in the host increases the severity of disease development as well as modifies the influence of the single factor, temperature, upon the respective host plants. The

[3] The writer begs permission to present in this summary form results obtained by associates and himself in co-operative research projects. The data upon which this report is based were obtained co-operatively between the Division of Cereal Crops and Diseases, Bureau of Plant Industry, United States Department of Agriculture, the Universties of Wisconsin and Illinois and Funk Brothers Seed Company. Credit for the work is due Dr. J. R. Holbert, Senior Agronomist, Dr. P. E. Hoppe, Associate Pathologist, Dr. A. D. Dickson Associate Biochemist, Division of Cereal Crops and Diseases and Dr. K. P. Link, Professor of Biochemistry, University of Wisconsin and formerly Agent, Division of Cereal Crops and Diseases, and others.

reactions of the two hosts illustrate the balancing effect of the various factors of the environment and the need of considering the combined influence of all factors of the environmental complex and their direct or indirect effect upon the metabolic processes initiated and continued within the plants, as well as their influence upon disease development.

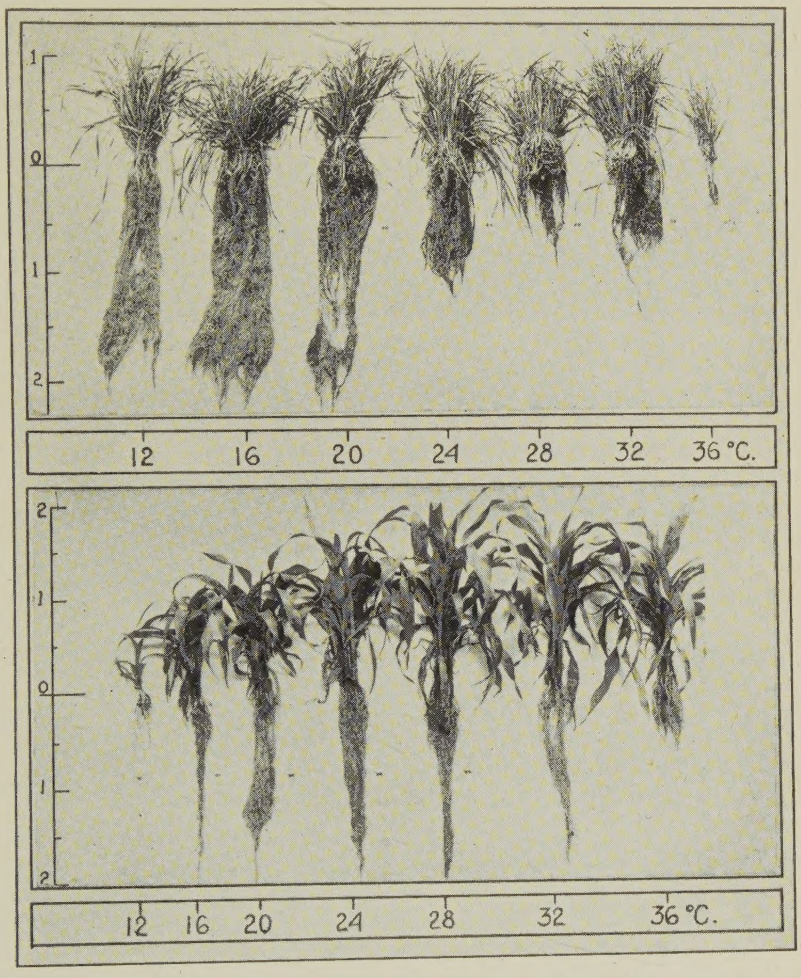

Figure 3. Showing the influence of soil temperature upon the development of winter wheat and corn seedlings. Wheat is a low temperature plant producing a large root system and well developed crown at 16°C. and below. Corn is a high temperature plant and developes best at 20°C. and above.

The wheat and corn metabolism is influenced differently at the various temperatures. The wheat seedlings grown at the low temperatures are relatively high in available carbohydrates of the hexose form, low in pentose carbohydrates, principally pectin and xylan, and very low in the water-soluble nitrogen fractions. In contrast, the wheat seedlings grown at the high temperatures are very low in hexose carbohydrates, including celluloses and hemicelluloses, high in pectin- and xylan-like compounds, and very high

in available nitrogen, especially asparagine. Respiration experiments show that the respiration coefficient increases rapidly at temperatures above 8°-12°C. In other words, the wheat seedling is relatively inefficient at the higher temperatures and oxidizes larger quantities of the hexose reserves, resulting in an unbalanced relation between the types of carbohydrates as well as the balance between available carbohydrates and nitrogen compounds. The corn seedlings are seemingly just the reverse of this condition although actually they are undergoing the same balancing of reactions, but over a different temperature range for the various processes than that occurring in the wheat seedling. The corn seedlings, grown at the low temperatures, are low in available hexose carbohydrates, as well as cellulose, very high in pectin and xylan-like substances, as well as high in pure xylan, and high in asparagine while the corn seedlings grown above 20-24°C. are high in available hexose carbohydrates, cellulose and subero-celluloses and low in available nitrogen. In this instance, the influence of temperature upon the enzymatic reactions and physiologic processes, both qualitatively and quantitatively in connection with the hydrolysis of the endosperm reserves, the condensation of compounds into mature tissues, and the efficiency of respiration, is different in the corn and wheat seedlings and results in distinctly different metabolic processes and types of cellular tissues in the two plants when grown at the same series of temperatures (Figure 4).

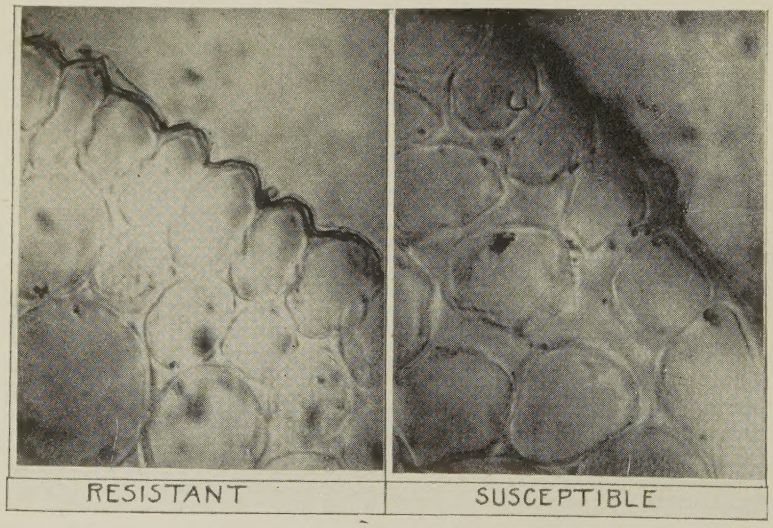

Figure 4. Showing cross sections of the cortex of the mesocotyl of the corn seedling after digesting in pectin and xylan solvents. The cortical cells of the disease resistant seedlings remain firmly cemented together with a well developed cutin over the epidermal cells. In contrast, the similar tissues of the disease susceptible seedlings are completely macerated by the action of the 0.5% ammonium oxalate and 1.0% sulphuric acid digestion. The thin layer of cutin is loosened from the epidermal cells. The resistant tissue requires a prolonged digestion in strong alkali, followed by chlorination before the tissue is macerated.

The study of the reaction and the analyses of disease and cold resistant, stable, inbred lines of corn gives further confirmation of the similarity of the general processes involved in the two seedling types reacting over a different temperature range. The resistant inbred lines, secured by growing the plants

in an unfavorable environment and selecting in the segregating populations and continuing inbreeding and selecting, remain resistant at temperatures as low as 12°-16°C. And here again there is the correlation between disease development or, in this case, expression of resistance to disease, and the general metabolism of the corn seedling. The resistant lines are capable of maintaining the stable balance of substances and processes and maturation of the protective cellular tissues over a greater range of temperatures or, stated inversely, are not influenced by temperatures that completely unbalance the unselected population.

Invasion of the host tissue by the parasite is through the protective cortical tissues. Fungus penetration in the development of the seedling blight occurs through the natural wounds at root ruptures, mechanical injuries and by direct penetration of the epidermis and exodermis of the protective sheath tissues, as well as through the endodermis in entering the central cylinder of roots and mesocotyl. There is seemingly then a direct correlation between disease development and host metabolism in both corn and wheat seedlings.

The advance of the parasite in the host tissue is correlated with the composition of the cortical tissues especially of the seedlings (Figure 4). The rapid invasion and rotting of the cortical tissues occurs in the wheat or corn seedlings high in pectin and xylan and available nitrogen. The pentosan substances are rapidly hydrolyzed and utilized as a source of carbon by the parasite, the asparagine offering an excellent nitrogen source for the fungus growth. This nutritive relation has been shown by growing the parasite in synthetic cultures using these substances isolated from corn as a source of carbohydrates and nitrogen. The resistant seedlings are always high in hexose carbohydrate compounds and low in available nitrogen which results in: (1) cellulose cell walls heavily impregnated with subero-cellulose and suberin or cutin, which inhibit fungus penetration and advancement; (2) deposition of suberin-like deposits in natural wounds or mechanical injuries, which quickly corks the fungus out; (3) low content of available nutritive substances for fungus growth; and (4) presence of acids, especially polyuronic compounds in the embryonic tissues. The resistant seedlings, whether in the case of the induced resistance brought about by the favourable environment or the inheritable resistance of selected strains, react similarly in disease development and indicate that the nature of resistance is a complex relationship closely correlated with host composition and function. Genetical studies show further that the inheritance of resistance is a complex of various factorial combinations the expression of which is closely associated with the metabolic processes of the host plants.

The Influence of Environment, During Maturation, Upon the Subsequent Behavior of the Corn Plant

The results reported are preliminary in nature, as the investigations have been conducted only three years and need much more experimentation and confirmation before they are complete. The data show, however, that by subjecting the seed to unfavorable environments during and previous to maturation in the autumn it is possible to modify the seedling functions and the behavior and uniformity of the plants. In other words, the influence

of the environment during the early period of sporophyte (embryo) development must be taken into consideration, as well as when growth has resumed after germination of the seed.

The expression of resistance is modified by an unfavorable environment prior to maturation. Inbred lines of corn and hybrid recombinations of these lines resistant to seedling blight produce ears bearing kernels that develop seedlings uniformly susceptible to seedling blight when grown the next season (Figure 5). If these unbalanced plants mature grain again in the autumn under the favorable environmental conditions, the resulting population resumes its characteristic stability of function and resistance to seedling blight. The unbalanced metabolic condition of the seedlings is illustrated by other modifications than the change in disease reaction. Modifications in chlorophyll formation commonly occur, including the segregation or mutation of albino plants. Lack of uniformity in reaction to low temperatures, in root development, in resistance to lodging, and in time of maturation and uniformity of ear have been recorded in many of the long time inbred lines of corn studied.

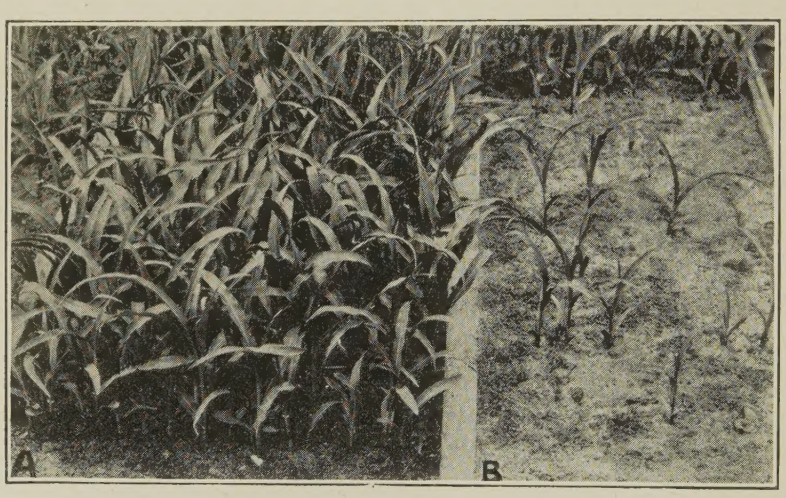

Figure 5. Showing the influence of the environment during maturation upon the expression of resistance to seedling blight. (A) Inbred lines of corn resistant to seedling blight caused by *Gibberella saubinetii* grown from seed matured at Bloomington, Illinois, an environment to which the strains are adapted. (B) The same inbred lines grown from seed matured at Madison, Wisconsin, under unfavourable conditions. The seedlings react differently to low temperatures, chlorophyll formation is irregular and the plants are susceptible to seedling blight.

Here again these disturbances are overcome by maturing the crop under a favorable environment the ensuing year. If, however, these lines are continued under the unfavorable environmental complex during maturation the second and third year and selection is practiced in the resulting population, new sublines may be obtained that are distinctly different in function from the original stable inbred lines.

These results would indicate perhaps that in genetical studies it is not sufficient to study only the factors concerned in inheritance, but the physiological processes by which the factors are expressed throughout the develop-

ment of the plant also must be recognized and considered. In other words, it may be necessary, as more detailed studies are made, to consider the internal environment in which the gene as the hereditary unit functions as well as the unit itself. Further studies upon the function of the plant through its metabolic processes and balances and their relation to the expression of genetic characters, may help explain the lack of uniformity in so-called homozygous lines where selection and inbreeding, even after fifteen years continuation have not resulted in uniform material either in function or form.

Fortunately when considered from the standpoint of heredity, plant and animal materials are relatively stable and extreme environmental changes are not common. The use of extreme combinations of the environmental complex may be more useful in inducing variations than the X-ray and other more drastic methods. Likewise it may aid in plant hybridizing in plant breeding programs and certainly should be used in analyzing segregating populations. In general, this phase of the problem must be considered in any well balanced crop adaptation program, especially when working with crop plants in locations along the margin of the region to which they are adapted.

The Human Factor in Research

The solution of problems of the type illustrated demands co-operation of a new order. Not only the agronomist and horticulturist but also the pathologist, geneticist, physiologist, biochemist, and meteorologist must co-ordinate their attack upon the problem to insure its correct analysis.

The influence of controlled experiments must be compared by means of standard material of known reaction with fluctuating field and regional conditions. This demands co-operation and co-ordination between provincial and dominion—state and federal—workers upon the details as well as upon the broader phases of crop adaptation. To illustrate this point of view; the plant disease then becomes a part of the environmental complex and the pathologist must, accordingly, orient himself in his attitude toward the problem and his associates. In other words, the solution of biological problems of this type has advanced beyond the scope of the individual investigator into the field of co-ordinated service in crop improvement.

The development of research projects of this type should stimulate individual leadership. The investigators must be sufficiently well trained in the fundamental sciences to demand the respect and enlist the aid of their co-workers in the pure sciences. Likewise, they must be broadly trained in biology and agriculture to sympathetically understand and appreciate the general aspects of the associates' point of view, even in the economic application of the problem. The success of such a project measured in research progress and training of men, is proportionate to the number of specialists assuming leadership in their particular phase of the problem. Each must have a general understanding of the biological principles involved combined with an appreciation of the other worker's contribution to the problem. Co-ordinated leadership has unlimited potentialities and is handicapped in its development principally by the lack of tolerance within the group and of sympathetic support by the administrator. Even with the numerous successful examples at hand, the greater majority of administrators are still thinking

sympathetically in terms of co-operation under the centralized leadership of one individual with the resulting inevitable restrictions where one man is attempting to do the major thinking on all phases of the problem. As the younger workers are trained to think in terms of leadership in co-operation and not in the specific superiority of their limited field and training in that subject, and as the expenditure of national and states funds in this period of economic stress is evaluated in terms of service to the constituency instead of the quantity of papers published, co-operation will develop into these co-ordinated research programs and will result in more able investigators, better research, and a greater service to the state.

CURRENT PUBLICATIONS

INFLUENCE OF SOIL TEMPERATURE AND SOIL STERILIZATION ON THE REACTION OF WHEAT SEEDLINGS TO *OPHIOBOLUS GRAMINIS* SACC. By A. W. Henry, Associate Professor of Plant Pathology, University of Alberta, Edmonton. Contribution from the Department of Field Crops, University of Alberta, Edmonton, with financial assistance from the National Research Council of Canada. Canadian Journal of Research, 7:2; 198-203. August, 1932.

In this investigation Marquis wheat seedlings reacted similarly to a virulent Alberta Strain of *Ophiobolus graminis* in sterilized and unsterilized soil at low temperatures, but differently at higher temperatures. At 13°C. for instance, the blighting was about equally severe in sterilized and unsterilized soil, but at 27°C. most of the seedlings were killed in the sterilized soil, while those in the unsterilized soil were only slightly attacked. The protective value to wheat of the constituents of unsterilized soil against soil-borne inoculum of *Ophiobolus graminis* appears, therefore, to vary with temperature, being under the conditions of these studies relatively slight at soil temperatures below 20°C.

GRAVENSTEIN SPOT SCALD[1]

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Samples of Gravenstein apples affected with an injury resembling scald were received during the late fall of 1930. The fruit had appeared normal and sound when packed and on its arrival at shipping destination. However, the day after exposure in shop windows the fruit was spotted and unmarketable.

Examination of affected apples showed that the spots were circular, depressed, light brown, and centred around a darkened lenticel (Figure 1). The individual spots varied in size from 1 to 10 mm. diameter but these frequently coalesced to form irregular depressed areas 15 to 20 mm. in diameter. The epidermis and 4 to 8 layers of the hypodermal tissue were collapsed and brown. Sound tissue lay adjacent to the majority of spots but occasional areas were found with progressive rot developing.

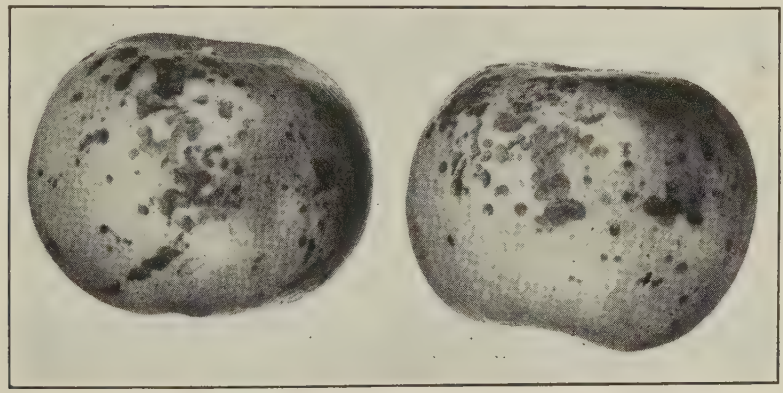

Figure 1. Gravenstein Spot Scald.

Isolation of possible pathogenic organisms was attempted. The majority of cultures were blanks, but a few developed *Alternaria* and other forms commonly found on the surface of apples.

In order to see if the disease would develop under observation Gravenstein apples held in common storage were removed to room temperature. Some were exposed to sunlight and the remainder left in subdued light. After one day, the time of the first observation after exposure, the apples in subdued light appeared perfectly sound, whereas those exposed to the light were more or less spotted in a manner typical of the first specimens received.

A second lot of apples from common storage comprising fruit from different fertilizer plots was put under two conditions of light. One lot was brought to the laboratory and exposed in a window; the other was exposed to the sun outdoors. The laboratory temperature varied from 68° to 72° and

[1] Paper read before the Canadian Phytopathological Society, Guelph, Ontario, June 1931. Contribution from the Division of Botany, Experimental Farms Branch, Dominion Department of Agriculture, Ottawa.

[2] Plant Pathologist in charge.

the maximum outdoor temperature was 42°. The actual temperature of the exposed fruit surface was not taken. Both lots of fruit were exposed to bright sunshine for 6 hours. After 4 hours small discoloured spots began to appear on the surface of the fruit, centred around the lenticels. By the time the fruit had been exposed for 6 hours the spots were very pronounced but not appreciably depressed. The following day the fruit was examined at intervals but no increase in size of spots could be discerned. The discoloured areas became depressed and the lenticels darkened but there was no increase in internal breakdown after the second day. The affected tissue adhered to the epidermal layer, when an attempt was made to peel the apples, leaving apparently healthy tissue immediately beneath with a few darkened vascular strands protruding outwards which had broken off in peeling. These browned vascular strands did not extend into the sound flesh of the fruit.

Microchemical tests with iodine potassium iodide, chloriodide of zinc and Sudan III. failed to show either the presence of starch or suberized tissue in the affected cells or any change in the cuticle. No starch was present in the sound tissue of the fruit.

A number of Gravensteins which had received the same fertilizer and spray treatments were subjected to dips in water, hot and cold, carbon tetrachloride and 1% nitric acid for periods of time varying from 1 to 60 minutes. The purpose of these dips was to remove any foreign materials present on the skin of the fruit which might have been toxic to the protoplasm. With the exception of the 1% nitric acid dip all treatments failed to prevent the symptoms appearing on the fruit when it was exposed, subsequent to treatment, to sunlight. The nitric acid apparently prevented some of the injury. Sodium nitroprusside and benzidine tests on the dip solutions failed to show the presence of sulphur.

Concurrently with the above tests a few apples were placed in water either completely or partially submerged, and exposed to light. Submerged fruits and the submerged portion of the partially submerged fruits were free from scald injury. It was also observed that the exposed portion of partly submerged fruit which scalded, developed a more superficial spreading scald than the control lots. A subsequent exposure to light of the submerged fruit, after wiping dry, caused a slight surface scalding more typical of scald disease in a mild form than of the spot scald under observation.

Fruit from another fertilizer plot but having the same treatment, was divided into several portions and wrapped in different coloured fruit wrapping paper both oiled and natural. Some of each lot were exposed to light and the remainder were kept in the dark at the same temperature. There was no appreciable difference in the amount of spot scald on fruit from any of these lots exposed to light even after 8 days. The fruits in the dark showed no injury.

Gravensteins, from a fertilizer plot which has shown considerable susceptibility to spot scald, were sampled for sugar analysis to determine the amount of sucrose or non-inverted sugars still present. The results are given in Table 1.

TABLE 1.—*Sugar in Gravensteins, plot 92, 1930. Average of six determinations on aliquots.*

Reducing sugars	Total sugars	Sucrose
9.031	9.067	0.036

From the above analyses it is apparent that the sucrose was practically all inverted at the time the samples were taken, i.e., after five months storage. The apples were still comparatively firm. There was no evidence of breakdown in the sampled fruit but the quality was not suitable for commercial purposes. Caldwell (*1*) found that after 10 to 20 days storage Gravensteins contained from 1.46 to 1.79% sucrose, with total sugars varying from 7.19 to 8.61 %.

Some of the Gravenstein fruits were tested before and after exposure to light, for glutathione, using the method described by White (*2*). The test on fruit before exposure to light gave a faint pink colour most concentrated immediately below the epidermis and adjoining the vascular bundles. The glutathione test on sections of the exposed fruit containing spot scalded areas gave a very pronounced pinkish brown colour to the collapsed tissue, extending from immediately below the cuticle to a depth of 6 to 8 layers of cells. Adjoining normal tissue remained apparently unaffected during the test.

DISCUSSION

The type of injury described above as "spot scald" has appeared only on mature fruit containing no starch in the pulp cells and practically no sucrose. The symptoms have not developed until the fruit was exposed to bright light. Temperature had little if any effect on the production of symptoms. Ventilation did not appear to influence the development of the condition. Comparing these factors with those influencing the development of apple scald it appears that this injury has other causes than volatile esters.

Since the symptoms of spot scald appear only in the light, on fruit containing no starch and little or no sucrose and centred around lenticels, it is probable that a photochemical reaction is at least partly responsible for the symptoms. Sulphur dioxide injury to vegetation is very similar in its environmental requirements to the above injury, but no positive reactions for sulphur on the skin of the fruit were obtained in the tests employed.

Glutathione has been found present in the flesh of the apple, by means of the sodium nitroprusside reaction. The relative quantity of this material in fruit at different stages of maturity has not been observed. The fact that a very pronounced response to the glutathione test was obtained from affected areas of the fruit surface indicates that this or some other compound containing sulphur may be partly responsible for the production of the spot scald symptoms described. Since glutathione is active in oxidation and reduction processes in other organisms a study of its possible relationship to apple maturity and storage life would be interesting.

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OAT STEM RUST INVESTIGATIONS IN CANADA[1]

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Introduction

The oat stem rust problem in Canada was considered to be of sufficient economic importance to merit special investigation when the Dominion Rust Research Laboratory was established at Winnipeg, Man., in 1925. Since then a program of attack on the problem has been carried on with the ultimate object of obtaining desirable resistant varieties or strains of oats which will eliminate or reduce the losses in Canada due to stem rust. The investigations of the problem have followed two lines. First, a study has been made of the occurrence and distribution in Canada of the physiologic forms of the casual organism, *Puccinia graminis avenae* Erikss. and Henn.; and secondly, a plant breeding program has been undertaken of sufficient scope to expect that satisfactory strains of oats will result, possessing the requisite resistance to at least the most prevalent physiologic forms.

The Geographic Distribution and Prevalence of Oat Stem Rust in Canada

Oat stem rust is widely distributed in Canada. Specimens of this rust have been obtained from Vancouver Island on the Pacific Coast to Nova Scotia on the Atlantic Coast, and from Mile 143 on the Hudson Bay Railway in northern Manitoba to the Niagara Peninsula in southern Ontario. The prevalence of this rust varies from year to year depending to a large extent on the environmental conditions existing each season in the various provinces. However, it is usually widespread in Manitoba and eastern Saskatchewan although appearing only occasionally in epiphytotic proportions. In 1927, this rust was extremely severe in its attack, more so than in any other year during the six-year period under consideration, 1925-30. In 1930, the attack was moderately severe. In British Columbia it occurs only to a slight extent and it is rarely of any consequence in Alberta. It occurs every year in Eastern Canada and, while not always severe in its attack, causes considerable damage.

The initiation of infection on oats each season in Western Canada is not dependent on the presence of the barberry or on overwintered urediniospores. The barberry is practically non-existent in Western Canada and the urediniospores have not been shown to be capable of surviving the winters. Primary infections each season are evidently due to spores being carried there by the wind from areas farther south. The subsequent prevalence of the disease depends on what stage of development the plants are in when the primary infections take place, and on the environmental conditions which later follow. In Eastern Canada the barberry is present, and undoubtedly it plays a part in the prevalence of the rust there. Its exact relation to the prevalance of oat stem rust there, however, has not as yet been investigated.

[1] Presented to the Canadian Phytopathological Society, Guelph, Ontario, June, 1931. Contribution from the Division of Botany and the Cereal Divisian, Experimental Farms Branch, Dep't Agriculture, Ottawa, Canada.

[2] Plant Pathologist and Cerealist respectively.

Physiologic Forms of Puccinia graminis avenae in Canada

Historical

The presence of physiologic forms of *Puccinia graminis avenae* in Canada was first reported in 1923 by Stakman, Levine and Bailey (*6*). They were able to isolate Forms 1, 2 and 5 from collections of oat stem rust obtained in Saskatchewan in 1921 and 1922. Bailey (*1*) in 1925 reported the isolation of Forms 1, 2 and 5 from collections obtained from Saskatchewan and Manitoba during 1921, 1922 and 1923. From a total of 26 collections of oat stem rust obtained from both Eastern and Western Canada during 1924, Bailey (*2*) again isolated the same three physiologic forms. Forms 3 and 4, previously unknown to occur in North America as well as Form 6, an exceedingly virulent form, were isolated from collections of oat stem rust obtained from Saskatchewan in 1925. The occurrence of these physiologic forms in Canada was first reported by Gordon and Bailey (*3*) in 1928. Gordon (*4*) in 1930 reported the effect of temperature on host reactions to eight physiologic forms of *Puccinia graminis avenae* isolated from collections made in Canada.

Methods and Materials Used in Determining the Physiologic Forms Present in Canada from 1925-1930

In order to determine the physiologic forms present in the various provinces, collections of oat stem rust were obtained each year and cultured in the greenhouse. The collections from Western Canada, particularly from Manitoba and Saskatchewan, were largely obtained by means of rust surveys carried on each year. The collections from Eastern Canada were obtained from rust nurseries established at Experimental Farms in the different provinces, by members of the several Dominion Laboratories of Plant Pathology.

With the exception of a few collections obtained on wild grasses and the barberry, all were collections of the uredinial stage of the organism on *Avena sativa* L. or *Avena fatua* L. The number of collections cultured each year varied greatly, depending largely on the prevalence of the disease. In 1925, only 60 collections were cultured, while in 1927 the number amounted to 344. The total number for the six-year period amounted to 1070. Approximately 85% of these collections were obtained from Western Canada.

The varieties or strains of oats which were used to differentiate the physiologic forms are given in Table 1. These differential hosts were first used by Bailey (*2*). The variety Victory, being susceptible to all the physiologic forms, was used as a host for general culture work. The physiologic forms were isolated and identified by the seedling reaction of the differential hosts. They were not identified under specially controlled environmental conditions.

Physiologic Forms of Puccinia graminis avenae Present in Canada During the Period, 1925-1930

From 1070 collections made in Canada during the six-year period, 1925-1930, nine physiologic forms were isolated. Usually only a single physiologic form was present in each collection but occasionally two or more forms were isolated from a given collection. The mean reactions of the differ-

ential hosts to the nine physiologic forms isolated are given in Table 1. In addition to Forms 1, 2 and 5, first reported as occurring in Canada by Stakman, Levine and Bailey (*6*) in 1923, six other physiologic forms were isolated. Forms 3, 4 and 6 were first isolated in 1925; Form 7 in 1928; Form 8 in 1929; and Form 9 in 1930. These physiologic forms are of special interest as all are more virulent than Forms 1, 2 and 5 (Table 1). The physiologic forms isolated from collections made in each province from 1925-1930 are shown in Table 2. Forms 1, 2, 5 and 6 were isolated each year during this period. Forms 1, 2 and 5 were also the most widely distributed geographically.

The comparative frequency of isolation of the physiologic forms is of interest (Table 3). Forms 1, 2 and 5 accounted for 96.5% of the total isolations made during the six-year period, 1925-1930. These physiologic

TABLE 1.—*The mean reactions of the differential hosts to nine physiologic forms of Puccinia graminis avenae.*

Forms	White Russian	Richland, Heigira Strain, Monarch Strain	Joanette Strain, Strain 703	Victory
1	3⁻c	2	1	4
2	3⁻c	2	4	4
3	4	2	1	4
4	4	4	1	4
5	3⁻c	2	X	4
6	4	4	4	4
7	4	2	4	4
8	3⁻c	4	4	4
9	3⁻c	3c	4	4

TABLE 2.—*Physiologic forms isolated from collections made in each province during the six-year period,* 1925-1930.

Province	Physiologic forms isolated					
	1925	1926	1927	1928	1929	1930
British Columbia	—	—	2, 5	2, 5	—	2
Alberta	—	—	1, 2, 5	1, 2, 5	1, 2	—
Saskatchewan	2, 3, 4, 5, 6	1, 2, 4, 5	1, 2, 4, 5	1, 2, 5	1, 2, 3, 5	2, 5
Manitoba	1, 2, 5	1, 2, 4, 5, 6	1, 2, 4, 5, 6	1, 2, 3, 4 5, 6, 7	1, 2, 3, 5 6, 7, 8	1, 2, 5, 6
Ontario	2	2, 4, 5	2, 5	1, 2, 5, 7	1, 2, 3, 4 5, 7	2, 7
Quebec	2, 5	2, 5	1, 2, 5	1, 2, 5	1, 2, 5, 7	2, 5
New Brunswick	2, 5	2, 5	2, 5	1, 2, 5	2, 5	5
Nova Scotia	2	5	2, 5	1, 2, 5	2, 5, 8	1, 2, 5, 7, 9
Prince Edward Island	5	5	4	1, 2, 5	—	—
Physiologic forms isolated in Canada	1, 2, 3, 4 5, 6	1, 2, 4, 5 6	1, 2, 4, 5 6	1, 2, 3, 4 5, 6, 7	1, 2, 3, 4 5, 6, 7, 8	1, 2, 5, 6 7, 9

forms were the most prevalent each year. They differ in their pathogenicity only on the differential hosts, Joanette Strain and Strain 703 (Table 1). Although they are the least pathogenic of all the forms of *Puccinia graminis avenae*, they are nevertheless widespread and have accounted for most of the oat stem rust in Canada each year. Forms 3, 4, 6, 7, 8 and 9 are more virulent but very rarely isolated. They have accounted for only 3.5% of the total isolations of physiologic forms made in Canada during the period under consideration. These virulent forms, while accounting for only 2.8% of the isolations from Western Canada, made up 7.1% of the total isolations of physiologic forms from Eastern Canada.

TABLE 3.—*The comparative frequency of isolation of the physiologic forms of Puccinia graminis avenae found in Canada during the period* 1925-1930.

Physiologic forms	Number of isolations	Per cent of total isolations
1	75	5.97
2	537	42.72
3	8	0.64
4	12	0.95
5	601	47.81
6	7	0.56
7	14	1.11
8	2	0.16
9	1	0.08

THE ARTIFICIAL INOCULATION OF THE BARBERRY WITH FORM 8.

During 1930, an attempt was made to study the physiologic forms of *Puccinia graminis avenae* by hybridizing them on the barberry. Teliospores of eight physiologic forms were produced on mature plants of the variety Victory grown in the greenhouse. These were treated after formation by the method which Johnson (*5*) found to be capable of inducing excellent germination of the teliospores of *Puccinia graminis tritici* Erikss. and Henn. However, only one of the physiologic forms of *Puccinia graminis avenae* responded to this treatment. Sufficient of the teliospores of Form 8 germinated to infect a young barberry plant growing in the greenhouse. The failure of the teliospores of the remaining physiologic forms to germinate did not allow the proposed hybridization work to be carried on. Therefore, a study could be made only of the cultures which were derived from aeciospores produced on the barberry by artificially inoculating it with Form 8. Data concerning these cultures are presented in Table 4. From the 20 cultures studied, Forms 6, 7 and 8 were isolated, thus showing the heterozygous nature of this physiologic form. Form 8 accounted for 15 isolations; Form 6 for 7 isolations; and Form 7 was isolated once. Only one physiologic form was isolated from a single aecial cup. It is interesting to note that the three physiologic forms isolated are all more virulent than the commonly occurring forms 1, 2 and 5, and that they had been isolated previously. The investigations along this line are being continued.

TABLE 4.—*Physiologic forms isolated from cultures obtained from a barberry artificially inoculated with form 8.*

Orgin of cultures	Number of cultures	Physiologic forms isolated	Frequency of isolation
Single cups	8	8	5
		6	3
Single pustules	8	8	5
		6	1
		6 & 8	2
Mass cultures	4	8	2
		6	1
		7 & 8	1

THE EFFECT OF ENVIRONMENT ON THE REACTIONS OF THE DIFFERENTIAL HOSTS TO PHYSIOLOGIC FORMS OF PUCCINIA GRAMINIS AVENAE

That changes in the environment of the differential hosts would affect their reaction to certain physiologic forms of *Puccinia graminis avenae* was first reported in 1929 by Waterhouse (7) from Australia. He found that the differential host Joanette Strain was resistant to Form 1 in the winter, susceptible to it in the summer, and gave a heterogeneous or "X" reaction in the spring and fall, but the reaction of this host to Forms 2 and 7 throughout the year was not significantly changed.

The results of a preliminary study on the effect of environment on the host reactions of physiologic forms of *Puccinia graminis avenae* in Canada were reported by Gordon (4) in 1930. The reaction of the differential host Joanette Strain in the seedling stage to Forms 1, 3, 4 and 5 was found to vary according to the temperature at which it was kept during the incubation period of the rust. A more extensive study of the response of the various physiologic forms to changes in their environment is now being carried on.

BREEDING FOR RESISTANCE TO STEM RUST

The object of the oat breeding work was to study the inheritance of reaction to stem rust, crown rust and smut, and to combine ultimately, resistance to these diseases with high yield in a single variety. Several crosses have been made in view of building up resistance to all these diseases, although stem rust has so far received the greatest amount of attention.

INHERITANCE OF REACTION TO STEM RUST

Several crosses were made with the view of building up resistance to Forms 1, 2, 3, 5 and 7 and also to obtain resistance to Form 4. Heigira Strain, which is resistant to Forms 1, 2, 3, 5 and 7 was used most extensively as the resistant parent in crosses with the higher yielding but susceptible varieties, Banner, Star, and Victory. A summary of the crosses made and the generations grown is given in Table 5.

Rust reaction was studied in the field and in the seedling stage in the greenhouse. In studying field reaction, an artificial rust epidemic was produced in which plants of Victory oats inoculated with Forms 1, 2, 3, 5 and 7

were transplanted in the field around the material to be studied. Heavy rust epidemics were produced by this method. In the greenhouse, seedlings were inoculated by using an inoculating needle.

TABLE 5.—*Crosses made and generations grown.*

Crosses made	Generations grown
Heigira Strain × Banner	F_1 F_2 F_3 F_4 F_5
Heigira Strain × Joanette Strain	F_1 F_2 F_3 F_4
Joanette Strain × (Minota - White Russian × Black Mesdag)	F_1 F_2 F_3
Richland × (Minota - White Russian × Black Mesdag)	F_1 F_2 F_3
Victory × Green Russian	F_1 F_2
Star × Heigira Strain	F_1
Victory × Heigira Strain	F_1
Banner × Iogold	F_1

Field reaction was determined in all crosses in the second and succeeding generations with the exception of the cross Joanette Strain × (Minota-White Russian × Black Mesdag). In all crosses resistance was found to be dominant and governed by a single genetic factor.

Three crosses only, were studied in the greenhouse, namely, Heigira Strain × Banner, Heigira Strain × Joanette Strain, and Joanette Strain × (Minota-White Russian × Black Mesdag). The reaction of each cross will be treated separately in the following discussion.

Heigira Strain × Banner

In this cross the progeny of 800 F^2 plants were inoculated with Form 2. Resistance to this form was found to be dominant and governed by a single factor. From the F^3 populations in the field, 100 susceptible and 100 resistant lines were selected on the basis of their field resistance, and resistance to Form 2 in the greenhouse. These were then inoculated with Forms 1, 2, 3, and 5 in the greenhouse and their reactions compared with that of the field. The data obtained showed that the reactions in both field and greenhouse were similar. At the time these isolations were made, Form 7 had not been isolated, so later, 91 of the above mentioned resistant lines, the susceptible lines having been previously discarded, were inoculated with Form 7. The data obtained showed that these lines were also resistant to this form. Therefore, from this cross lines resistant to Forms 1, 2, 3, 5 and 7 have been produced and, furthermore, the evidence that the reactions to these forms are inherited as a group and controlled by a single genetic factor is conclusive.

Heigira Strain × Joanette Strain

As Joanette Strain is resistant to Form 4 (Table 1), 136 F^2 plants showing field resistance were selected and their progeny inoculated with Form 4 in the

greenhouse. From this number, 21 lines resistant to Form 4 were obtained. These 21 lines were then inoculated with Forms 1, 2, 3, 5 and 7 in the greenhouse and their reaction compared with that of the field. The data obtained in this cross, also showed that field and greenhouse reactions were similar. Therefore, in this cross, also, the reactions to Forms 1, 2, 3, 5 and 7 are governed by the same factor and inherited as a group, while the reaction to Form 4 is inherited independently. From this cross 9 lines resistant to Forms 1, 2, 3, 4, 5 and 7 have been produced.

Joanette Strain × (Minota-White Russian × Black Mesdag)

As the latter parent is resistant to both loose and covered smuts the object of this cross was to combine the rust and smut resistance. At the present time, data on the reactions of the progeny of this cross to Form 4 have been studied. Two hundred and twenty-five lines were inoculated in F^3 with Form 4. The data obtained showed that the reaction to this form was governed by a single factor and that resistance was dominant.

Rod Row Data

Strains of the two crosses, Heigira Strain × Banner, and Heigira Strain × Joanette Strain, have been placed in a rod row test. One year's results only, have been obtained on the latter cross. The yields were not high as neither parent produces very high yields. Owing to their resistance to Form 4, as well as to Forms 1, 2, 3, 5 and 7, the value of these strains lies in their usefulness in crossing with the higher yielding strains. Strains of the Heigira Strain × Banner cross, on the other hand, have been in a rod row test for two years and some fairly high yielding strains resistant to approximately 98% of all the isolations of physiologic forms made in Canada during the period 1925-1930, have been produced. Grown under heavy rust conditions these strains were free from rust, producing yields as high as 80 bushels, while the high yielding varieties, Banner, Star and Victory, showed approximately 90%, giving yields as low as 20 bushels.

Summary

1. Investigations of oat stem rust, *Puccinia graminis avenae*, carried on in Canada during the six year period, 1925-1930, have dealt with the occurrence and distribution of the physiologic forms of this rust and the breeding of desirable strains of oats resistant to several of them.

2. Physiologic forms of *Puccinia graminis avenae*, were isolated from 1070 collections of oat stem rust obtained from the various provinces of Canada. The majority of the collections were made in Western Canada. A total of 1257 isolations of physiologic forms was made.

3. Nine physiologic forms were isolated during the period from 1925-1930. Six of these forms were previously unknown to occur in Canada.

4. Forms 1, 2 and 5 were the most prevalent forms, accounting for 96.5% of the total isolations. Forms 3, 4, 6, 7, 8 and 9 were isolated rarely although all are more virulent than Forms 1, 2 and 5.

5. Forms 6, 7 and 8 were isolated from cultures obtained from a barberry artificially inoculated with Form 8. Only one physiologic form was isolated from a single aecial cup.

6. In the oat breeding work, several crosses were made in an attempt to combine high yield with resistance to Forms 1, 2, 3, 4, 5 and 7 of *Puccinia graminis avenae.*

7. Fairly high yielding strains of oats have been produced resistant to approximately 98% of all the isolations of physiologic forms made in Canada during the six-year period, 1925-1930.

8. The inheritance of the reaction to stem rust of the adult plants in the field is apparently controlled by the factors which govern the inheritance of the reaction to seedlings in the greenhouse.

9. The inheritance of rust reaction in a Heigira Strain × Banner cross, was found to be governed by a single dominant factor.

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CURRENT PUBLICATIONS

LEGUME INOCULATION. A. Grant Lochhead. Dominion of Canada, Department of Agriculture Bulletin No. 157. New series.

This bulletin provides a more complete description of the value and methods of legume inoculation than is available from the usual leaflets provided with nitrocultures. The bulletin should prove a valuable addition to the farmer's library and is an excellent text on the subject for junior farmers short courses and farm short courses generally. Copies are available from the Publications Branch, Department of Agriculture, Ottawa. —H.L.T.

FISH MEAL SUPPLEMENTS FOR CHICKS

1. COMPARATIVE RATE OF GROWTH-TO-EIGHT-WEEKS ON RATIONS SUPPLEMENTED WITH PILCHARD, SALMON, HALIBUT, DRIED SKIM MILK OR WITH SALMON MEAL AND DRIED SKIM MILK.

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Rations for chicks generally contain meat meal, fish meal or milk to supply the chicks with proteins and minerals. In most cases these supplements, singly or in combination, will, if fed in sufficient amounts with a suitable basal ration, ensure satisfactory growth. Prange, Carrick and Hauge (*11*) found, however, that meat scraps differ in value as measured by the rate of growth of chicks. Moreover, these investigators (*9*) demonstrated that one of the commercial meat meals tested by them gave unsatisfactory growth, apparently due to trytophane deficiency.

Card (*1*) obtained equally good growth on sour skim milk, fresh buttermilk, condensed buttermilk and dried buttermilk. Mussehl and Ackerson (*7*) have, however, found that chicks fed rations supplemented with dried buttermilk and meat meal grew better than chicks fed rations supplemented with dried skim milk and meat meal.

In most cases no distinction has been made between meals made from different species of fish. Furthermore, variations in the quality of fish meals, whether made from the same or from different species, have not apparently been considered. Recently, however, Titus, McNally and Hilberg (*15*) have reported that two fish meals (North Atlantic and Menhaden) gave similar results but proved less efficient than the meat meal tested. Munro and Rae (*6*) also report a slower rate of growth of chicks when a commercial sample of fish meal was substituted for milk. However, Daniel and McCollum (*2*) found that the fish meals tested by them were superior to the meat products with which they were compared. Their results showed that the method of preparation largely accounted for such differences as were observed between different fish meals.

Experimental

In order to obtain further information the various fish meals available in British Columbia were compared to one another and to milk as protein supplements for chicks.

Three fish meals, made from salmon (*Oncorhynchus*), halibut, (*Hippoglossus hippoglossus*) and pilchard (*Sardinea cerulea*) respectively, were selected for these tests. Salmon and halibut meal are made almost entirely from cannery refuse while pilchard meal is made from the whole fish after most of the oil has been extracted. Skimmed milk, dried by the vacuum process, was used and will, for the sake of brevity, be referred to simply as milk.

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The basal mixture used consisted of 50 lbs. cornmeal, 10 lbs. wheat bran, 10 lbs. flour wheat middlings, 10 lbs. ground oat groats, 3 lbs. bone meal, and 1 lb. salt. Cod liver oil at the rate of 1% was mixed into the mash every two weeks. The ash and protein content of this basal mixture and of the various protein supplements used in these experiments are shown in Table 1.

TABLE 1.—*Ash and protein content of the feeds used.*

	Experiment 1		Experiments 2, 3, 4 and 5	
	Ash Per cent	Protein Per cent	Ash Per cent	Protein Per cent
Halibut meal	22.97	57.8	25.22	53.46
Salmon meal	18.62	55.6	22.69	51.19
Pilchard meal	19.33	61.3	15.51	66.41
Dried skim milk	8.04	36.1	8.13	35.96
Basal mixture	6.64	11.2	7.58*	11.33*
Bone meal	82.46		84.63	4.55

* These figures are for Experiment 2 only.

Enough of each supplement was used to supply 10, 7.5 or 5% of protein. In the first two experiments bone meal was added to correct for differences in ash content and the basal used to make up to 100 lbs. The amount of each of these parts used in the various rations is shown in Tables 2 and 6. While the different rations, due to the differences in the amount of the basal mixture, varied in protein content, the variation was slight as shown in Tables 3 and 6, except for the milk rations which were somewhat lower in protein than corresponding rations containing fish meal or fish meal and milk.

STOCK

The stock used comprised the following: Experiment 1—B.P. Rock and R.I. Red chicks; Experiment 2—Crossbred chicks (R.I. Red ♀ × Australorp ♂); Experiments 3, 4 and 5—Crossbred chicks (B.P. Rock ♀ × Australorp ♂). In Experiments 3, 4 and 5 the chicks were divided according to sex so that there was the same number of cockerels and pullets in each lot at the start of the experiment. The chicks were also divided according to ancestry so far as possible by distributing the chicks from each hen into as many different lots as possible.

The chicks were taken from the incubator when 24 hours old, weighed and placed in battery brooders. The battery brooders were four tiers high. Each tier was divided into two compartments, each 24 by 30 inches, with a sliding door between so that the chicks could be confined to one compartment when desired. One of the two compartments in each tier was

heated by three carbon filament lamps. Since there was no thermostatic control the temperature varied somewhat according to the weather.

Comparison of Different Fish Meals and Milk

Two experiments were carried out for the purpose of comparing halibut meal, salmon meal, pilchard meal and dried skim milk as supplements for chicks. As stated above, the analyses of these supplements and the basal mixture are given in Table 1, the amount of each of the supplements added to the ration to supply 10 pounds (per cent) of protein in Table 2, while the total amount of protein and ash in each ration is shown in Table 3.

Table 2.—*Rations fed in Experiments 1 and 2.*

Experiment and Lot No.	Protein Supplement		Amount of Basal Mixture	Amount of Bone Meal Added
	Kind	Amount		
1a	Halibut	17.3 lbs.	82.7	
1b	Salmon	18.0 "	81.3	0.7
1c	Pilchard	16.3 "	82.7	1.0
1d	Dried Skim Milk	27.7 "	70.2	2.2
2a	Halibut	18.7 lbs.	81.3	
2b	Salmon	19.5 "	80.5	0.4
2c	Pilchard	15.1 "	84.9	2.5
2d	Dried Skim Milk	27.8 "	72.2	3.7

Table 3.—*Ash and protein content of the rations calculated from Tables 1 and 2.*

Ration		Experiment 1		Experiment 2	
Lot No.	Protein Supplement	Ash Per cent	Protein Per cent	Ash Per cent	Protein Per cent
1a, 2a	Halibut	9.46	19.26	10.88	19.21
1b, 2b	Salmon	9.33	19.11	11.06	19.12
1c, 2c	Pilchard	9.47	19.25	10.89	19.76
1d, 2d	Dried skim milk	8.70	17.86	10.86	18.35

The average weights of the chicks in the different groups at two-week intervals up to eight weeks are presented in Table 4. It will be seen that the chicks that received milk grew slightly better than those fed the various fish meals. However, when the weights of males and females at eight weeks, taken from Experiments 1 and 2, are compared (Table 5) it is apparent that the difference in weight between the groups fed milk and the groups fed salmon was not significant. Furthermore the chicks

on the pilchard meal ration grew as well as those given milk or salmon. The heavier mortality among chicks in Lot 2 c (Table 4) was probably due to chilling or other environmental factors rather than to the pilchard meal fed. It should be noted, however, that the pilchard meal used in this experiment differed from that used in Experiment 1 and may have been inferior. Despite the lower rate of growth of these chicks (Lot 2 c) the differences between the lots fed pilchard, salmon or milk are not significant. These experiments thus definitely show that some fish meals will produce just as rapid growth as dried skimmed milk when they are fed at a level to supply 10% of protein in the ration.

TABLE 4.—*Average weights of chicks. Experiments 1 and 2.*

Expt. and Lot No.	Supplement	No. of chicks started	No. of chicks survived	Weight of Chicks			
				2 weeks	4 weeks	6 weeks	8 weeks
				grams	grams	grams	grams
1a	Halibut	36	24	87.0	186.6	358.5	598.9
1b	Salmon	35	22	87.9	197.8	401.0	656.1
1c	Pilchard	35	23	85.5	194.0	382.0	660.0
1d	Dried skim milk	34	23	82.4	193.9	391.6	675.5
2a	Halibut	28	11	80.4	180.4	333.3	556.5
2b	Salmon	25	13	82.7	201.1	369.0	591.3
2c	Pilchard	25	5	80.6	157.8	343.4	530.6
2d	Dried skim milk	25	19	87.9	218.4	394.7	615.1

TABLE 5.—*Differences in average weights of chicks fed the supplements indicated. The average weight of the chicks on the last named supplement was subtracted from that of chicks on the first named supplement.*

Expt. No.	Sex	Milk-Salmon	Milk-Pilchard	Milk-Halibut	Salmon-Pilchard	Salmon-Halibut	Pilchard-Halibut
		gms.	gms.	gms.	gms.	gms.	gms.
1	Male	− 1.9	+19.0	+31.8	+20.9	+33.7	+12.8
1	Female	+28.6	+18.7	+59.7	− 9.9	+31.1	+41.0
2	Males and Females	+23.8	+84.5	+58.6	+60.7	+34.8	− 25.9
Odds that the differences are significant		8:1	9:1	62:1	45:1	1899:1	2:1

The chicks fed halibut grew more slowly than the other lots in Experiment 1 and were exceeded in weight by the chicks fed milk and the chicks fed salmon in Experiment 2. In other words, the chicks fed halibut weighed consistently less at eight weeks than the chicks fed milk or salmon, the differences being statistically significant. (Table 5). These results indicate that the halibut fish meals here tested were slightly inferior to the salmon meals as protein supplements for chicks.

The results obtained in Experiments 1 and 2 demonstrate that the various meals tested are not equal in value as measured by the weight of chicks at eight weeks. This may be partly due to differences between the various species of fish and partly to the fact that some meals (pilchard) are made from the entire fish while others (salmon and halibut) are made only from the parts of the fish not used for canning. The data further indicate that different meals from the same species may differ sufficiently to influence the rate of growth obtained. The reasons for these variations are not clear from our experiments, but it is obvious that results obtained with one fish meal will not necessarily be obtained with other fish meals. Hence, it is important to know the kind and quality of any fish meal used Some of the causes of variation in quality of fish meal are indicated by the results reported by Ingvaldsen (*4*), who found that putrefaction lowers the tyrosine, tryptophane and cystine content of fish meal while high temperatures (195°C.) cause a diminution in arginine-nitrogen and cystine and an increase in humin and volatile basic nitrogen. The work of Daniel and McCollum (*2*) further emphasizes the relatively important part played by the methods and the care taken in preparing the meals.

Comparison of Salmon and of Salmon and Milk at Different Levels

Although in the first two experiments equally good growth was obtained with fish meal as was obtained with milk it appeared desirable to carry out further work to determine whether (a) more rapid growth could be secured by combining fish meal and milk than by feeding one of these only and (b) the approximate optimum amount of protein required with the basal ration used in these experiments. Experiments 3, 4 and 5 were planned to furnish evidence on these points.

The same basal mixture was used in these experiments (3, 4 and 5) as before (Experiments 1 and 2) except that 3 pounds of pulverized oyster shell was substituted for the 3 pounds of bone meal. The proportion (per-

TABLE 6.—*Rations fed in Experiments 3, 4 and 5.*

Lot Nos.	Amount of Basal Mixture	Salmon Meal		Dried Skim Milk		Protein Total	
		Total Amount	Amount of Protein	Total Amount	Amount of Protein	from Supplements	in the ration (calculated)
3a – –	72.2			27.8	10.0	10.0	18.16
3 b – –	86.1			13.9	5.0	5.0	14.73
3c 4a 5a	80.5	19.5	10.0			10.0	19.10
4b 5b	85.4	14.6	7.5			7.5	17.15
3d 4c 5c	90.2	9.8	5.0			5.0	15.19
3e 4d 5d	76.3	9.8	5.0	13.9	5.0	10.0	18.62
4e 5e	82.3	7.3	3.75	10.4	3.75	7.5	16.80
4f 5f	88.1	4.9	2 5	7.0	2.5	5.0	14.96

centage) of the basal mixture and of the supplements in the various rations is shown in Table 6. The supplements were added in such amounts as to supply 10, 7.5 or 5% of protein in each case. No attempt was made to correct for differences in mineral constituents.

In the first two experiments there was a considerable number (about 20%) of chicks that developed slipped tendons. Oyster shell was then substituted for the bone meal in an attempt to reduce the incidence of slipped tendons. There were some cases in Experiments 3, 4 and 5, but the proportion was much lower. It is also of interest to note that no cases of cannibalism (toe picking, etc.) occurred in any of these experiments.

In Experiment 3 the mortality was highest in Lots 3 c and 3 d which were fed salmon to supply 10 and 5% protein. The average mortality among the various lots of chicks fed salmon at a level to supply 10% was slightly higher than the mortality in the lots which were fed less salmon or salmon and milk. It is apparent, however, that the kind of protein supplement had no influence on mortality in Experiments 4 and 5 (Tables 8 and 9), but the amount of protein supplement apparently had an effect since the mortality was least in the case of the chicks on the lowest protein rations. There was no difference in this respect between the chicks on the intermediate and highest protein rations.

TABLE 7.—*Average weights of chicks in Experiment 3.*

Lot	Sex	No. Died	No. Survived	Av. Wt. 1 day	Av. Wt. 2 weeks	Av. Wt. 4 weeks	Av. Wt. 6 weeks	Av. Wt. 8 weeks
3 a	Male		4	40.3	61.5	167.5	306.5	566.0
	Female		4	41.3	64.5	148.0	296.0	521.0
	Total	12	8	40.8	63.0	157.8	301.3	543.5
3 b	Male		10	40.8	83.8	167.0	330.0	578.0
	Female		7	42.3	82.9	153.3	294.4	510.0
	Total	1	17	41.4	83.4	161.3	315.3	550.0
3 c	Male		2	40.5	80.0	153.5	336.5	603.0
	Female		7	40.7	92.1	191.9	378.0	614.7
	Total	9	9	40.7	89.4	183.3	368.8	612.1
3 d	Male		5	40.8	80.8	168.8	332.0	558.8
	Female		7	40.0	80.9	176.6	355.4	604.7
	Total	7	12	40.3	80.8	173.3	345.7	585.6
3 e	Male		9	41.4	98.4	213.1	453.6	756.7
	Female		8	40.7	90.0	194.2	418.5	656.5
	Total	2	17	41.1	94.4	204.2	437.4	708.0

Effect of Combining the Protein Supplements

The average weights of the chicks to eight weeks of age in Experiments 3, 4 and 5 are presented in Tables 7, 8 and 9. The averages for the males and females are given separately and also the weighted averages for each lot.

TABLE 8.—*Average weights of chicks in Experiment 4.*

Lot	Sex	No. Died	No. Survived	Av. Wt. 1 day	Av. Wt. 2 weeks	Av. Wt. 4 weeks	Av. Wt. 6 weeks	Av. Wt. 8 weeks
4a	Male		7	40.0	86.1	195.1	339.0	554.8
	Female		12	38.9	72.5	171.5	310.6	517.2
	Total	2	19	39.3	77.5	180.2	326.3	530.5
4b	Male		11	39.5	95.1	246.0	435.0	659.8
	Female		7	38.4	77.7	188.1	338.4	501.3
	Total	2	18	39.1	88.3	223.5	397.4	598.2
4c	Male		12	40.8	79.3	167.2	325.2	504.1
	Female		5	40.8	75.8	166.4	302.4	448.4
	Total	1	17	40.8	78.2	166.9	318.5	491.2
4d	Male		7	39.7	101.1	243.6	438.4	689.0
	Female		9	39.6	95.2	223.4	408.0	649.1
	Total	5	16	39.6	97.8	232.3	421.3	666.6
4e	Male		10	40.0	95.4	218.0	440.4	673.0
	Female		7	40.3	87.4	201.9	393.3	575.3
	Total	4	17	40.1	92.1	211.4	421.0	632.8
4f	Male		10	39.7	81.5	181.0	337.2	471.0
	Female		9	38.7	76.7	173.6	306.4	429.2
	Total	2	19	39.2	79.2	177.5	322.6	451.2

The effect of feeding fish meal or milk as compared with feeding a combination of these may be considered first. Only in Experiment 3 (Table 7) can the weights of chicks fed milk (Lot 3 a) be compared with the weights of chicks fed milk and salmon (Lot 3 e). The latter grew more rapidly, the difference at eight weeks being 157.7 $\pm$ 25.2 grams. This difference is significant but the comparison is not valid since the chicks fed milk only (Lot 3 a) were accidentally starved when they were just over two weeks old and hence, grew more slowly than chicks fed similar rations in Experiments 1 and 2 (Table 4). The mortality was also higher than in preceding experiments. It is evident, however, that the lots fed a combination of salmon and milk (Lots 3 e, 4 d and 5 d) compare favourably in weight and mortality with the chicks receiving the same percentage of protein from milk. The former were slightly heavier (based on weighted

TABLE 9.—*Average weights of chicks in Experiment 5.*

Lot	Sex	No. Died	No. Survived	Av. Wt. 1 day	Av. Wt. 2 weeks	Av. Wt. 4 weeks	Av. Wt. 6 weeks	Av. Wt. 8 weeks
5a	Male		10	40.3	95.2	163.2	309.0	581.0
	Female		9	39.1	90.2	152.9	300.3	536.4
	Total	4	19	39.7	92.8	158.3	304.9	559.9
5b	Male		9	40.6	94.4	142.2	303.8	544.7
	Female		8	38.4	81.3	126.5	262.5	484.5
	Total	6	17	39.5	88.2	135.1	284.4	516.4
5c	Male		6	40.2	83.7	138.0	242.7	460.0
	Female		10	40.8	76.8	130.4	247.2	453.0
	Total	1	16	40.6	79.4	133.3	245.5	455.6
5d	Male		11	39.2	105.8	201.7	384.2	673.5
	Female		8	38.4	102.3	180.0	359.0	633.3
	Total	4	19	38.8	104.3	192.6	373.6	656.5
5e	Male		8	39.5	107.3	207.5	370.5	625.8
	Female		11	39.9	99.8	173.1	342.5	594.0
	Total	3	19	39.7	103.0	193.4	354.3	607.2
5f	Male		10	38.7	88.8	159.8	313.8	562.8
	Female		8	40.9	71.8	130.8	250.5	436.8
	Total		18	39.7	77.0	146.9	285.7	506.8

averages) at eight weeks and the mortality was also lower. It may, therefore, be concluded that somewhat better growth is to be expected from a combination of milk and fish meal than from milk alone when these are fed in such amounts as to supply 10 per cent. of protein. Since fish meals contain more protein per pound than milk, less of the combined supplements would be necessary to supply a given amount of protein. Furthermore, since fish meal usually costs less than milk, it is obvious that it is more economical to feed a combination of milk and fish meal than to feed milk only.

As shown in Table 6, eight lots were fed salmon meal at three different levels and similarly seven were fed a combination of salmon and milk. The protein supplied by these supplements at the different levels was 10, 7.5 and 5%, or the difference between successive levels was 2.5%. The actual difference in the protein content of the rations was, however, less than 2% (Table 6).

The results for this series of trials are presented in Table 7, 8 and 9, but in order to facilitate a comparison of the results obtained with salmon and milk as against salmon the differences were calculated and are set

forth in Table 10. The chicks fed salmon and milk grew better and were, in every case, heavier at eight weeks than the chicks fed salmon only, when these supplements provided 10% of protein. The differences range from 92.5 to 153.7 grams and 41.8 to 131.9 grams for the males and females respectively. The odds calculated by "Student's" method, (Hayes and Garber (*3*), show that these differences are statistically significant.

When these supplements were fed at a level to supply 7.5% of protein the rate of growth was again better in the case of the chicks fed a combination of milk and salmon. This difference, while less than when these supplements were fed at a higher level, was still statistically significant (odds 46.7: 1).

There was no difference in the weights of the chicks when the supplements furnished 5% of protein. Only in the case of the males in Experiment 5 did the chicks which were fed milk and salmon grow more rapidly than those fed salmon, while the females which were fed the salmon supplement weighed slightly more at eight weeks in both experiments.

TABLE 10.—*Differences in weight of chicks at 8 weeks. The average weight of the chicks fed salmon was substracted from the average weight of the chicks fed salmon and milk.*

Amount of protein supplied by the supplements in each 100 lbs. of the ration		10.0 lbs. (per cent)	7.5 lbs. (per cent)	5.0 lbs. (per cent)
Expt. No.	Sex	Salmon and milk: Salmon	Salmon and milk: Salmon	Salmon and milk: Salmon
		gms.	gms.	gms.
3	Male	153.7		
3	Female	41.8		
4	Male	134.2	13.2	–33.1
4	Female	131.9	74.0	–19.2
5	Male	92.5	81.1	102.0
5	Female	96.9	109.5	–16.2
Odds that the differences are significant.		1428.0:1	46.7:1	1.5:1

The results in Table 10 form a consistent series in that the combination of milk and salmon produced definitely better growth at the highest protein level, a definite but not quite as great increase in growth at the intermediate level, while at the lowest level there was no increase in weight over the chicks fed salmon only. It would appear probable that the limiting factor at the lowest level is quantity of protein present, while at the higher levels the limiting factor is probably qualitative or quantitative in the sense of applying only to a certain amino acid or acids. It cannot, however, be asserted that the supplementary value of these feeds at the higher levels is due to their protein content since it may be a matter of minerals or some other nutrients. In connection with these results it is of interest to note that Roberts (*12*) reports better growth to ten weeks

on a ration containing 12% meat scrap and 4% dried butter milk than on a ration containing 15% meat scrap but no milk. Milne (*5*) also obtained better growth on a ration containing fish meal, meat meal and dried skim milk than on rations containing the milk only. The results reported by Roberts and by Milne agree with the data presented in this paper in that a combination of protein supplements produced better growth than one supplement.

Effect of Different Protein Levels

In Experiments 3, 4 and 5 different levels of protein from salmon or salmon and milk were fed, as shown in Table 6. Only two lots (3 a and 3b, Table 7), are available for a comparison of the effect of feeding milk at different levels. There is no difference in their weights at eight weeks but as stated above the lot (3 a) fed milk at a level to supply 10% of protein did not grow as well as previous lots fed a similar ration. It is, therefore, significant that the lot (3 b) fed milk to supply 5% of protein did not grow better than Lot 3 a. Moreover, the chicks receiving 5% of protein from milk weighed slightly less than the chicks (Lot 3 d) fed a corresponding level of salmon meal. It seems clear that chicks fed the lower protein milk ration will not grow as rapidly as those fed the higher protein milk ration.

It is apparent (see Tables 7, 8 and 9) that the rate of growth of chicks fed milk and salmon varied (although not necessarily in direct proportion) according to the amount of protein supplement fed. The results are different in the case of the chicks which were fed salmon since the chicks fed the higher levels did not show any consistent difference (see Tables 8 and 9). In all cases the chicks fed the lowest protein rations weighed least, on the average, at eight weeks. The differences in the growth rates on different protein levels are shown clearly by the weighted average weights at eight weeks which were 558, 558 and 502 grams for the chicks fed salmon to supply 10, 7.5 and 5% of protein respectively. The corresponding weights for chicks fed salmon and milk were 676, 619 and 478 grams.

In order to determine whether the differences in the weights of the chicks fed rations to supply the various levels of protein are significant the differences were computed separately for the males and females and the odds calculated from these. The results (Table 11) show that the differences in weight at eight weeks between the chicks fed salmon to supply 10 and 7.5% are not statistically significant. The chicks fed 10% of protein from salmon and milk weighed significantly more at eight weeks than those fed only 7.5% of protein from these supplements. The chicks that received only 5% of protein from the supplements grew more slowly than the chicks on the higher protein levels and weighed significantly less at eight weeks regardless of whether they were fed salmon and milk or salmon only. These results are consistent with those noted above (Table 10) which showed that there was no advantage in feeding both milk and salmon at the lowest level (5%) and that the difference in favour of milk and salmon as compared with salmon alone was greater at the highest than at the intermediate protein level.

TABLE 11.—*Differences in weight of chicks at 8 weeks fed different levels of protein from salmon or salmon and milk.*

Protein Supplements		Salmon			Salmon and Milk		
		Protein (from supplements) levels compared.					
Expt. No.	Sex	10.0: 5.0	10.0: 7.5	7.5: 5.0	10.0: 5.0	10.0: 7.5	7.5: 5.0
		gms.	gms.	gms.	gms.	gms.	gms.
3	Male	44.2					
3	Female	10.0					
4	Male	50.7	−105.0	155.7	218.0	16.0	202.0
4	Female	68.8	15.9	52.9	219.9	73.8	146.1
5	Male	121.0	36.3	84.7	110.7	47.7	63.0
5	Female	83.4	51.9	31.5	196.5	39.3	157.2
Odds that the differences are significant		216:1	0	35:1	322:1	58:1	124:1

The results with salmon and milk agree while the results with salmon meal differ from those obtained by Norris and Heuser (*8*) who fed meat scrap and report an increase in weight at eight weeks with increases in protein up to 20%. St. John et al (*13*) also found that the rate of growth was increased when dried skim milk was increased up to 25.76% and the protein content of the ration raised to 17.17%. Furthermore, Swift et al (*14*) report better growth on rations containing about 20 to 21% protein than on rations with less protein.

Prange, Carrick and Hauge (*10*) obtained best results with a protein level of 10 to 12% from the meat meal fed. This is slightly higher than the optimum level with salmon which appears to be around 7.5% of protein or about 15 pounds of salmon in each 100 pounds of mash. As stated above, a more rapid rate of growth can be obtained by increasing the protein level from 7.5 to 10% if salmon and dried skim milk are fed. The increase in rate of growth was, however, much less for an increase in protein from 7.5 to 10% than that obtained by raising the protein (from salmon and milk) from 5 to 7.5% or 57 grams (9.2%) as compared with 141 grams (29.5%). Hence there appears to be little advantage in adding more of the protein supplement than is required to supply 7.5% of protein.

SUMMARY

Five experiments are reported on the comparative rate of growth of chicks (R.I. Red, B.P. Rock and crosses of these with Australorps) raised to eight weeks in battery brooders on rations supplemented with pilchard, salmon, halibut, dried skim milk or with salmon and dried skim milk.

In Experiments 1 and 2 there was no significant difference in the average weight of chicks at eight weeks when fed rations supplemented

with salmon meal, pilchard meal or dried skim milk to supply 10% of protein. The chicks which were fed pilchard meal were, however, more variable in weight at eight weeks than the chicks which were fed salmon or milk. The chicks which were fed halibut were slightly but consistently lighter in weight at eight weeks than the chicks given salmon or dried skim milk. The average weights at eight weeks of the chicks receiving the various supplements were as follows: halibut— 585.6 grams; pilchard—636.9 grams; salmon—632.0 grams; dried skim milk—648.2 grams.

Salmon alone and salmon and dried skim milk were fed at different levels to determine whether a combination of these supplements would give better results than if only one were fed. In the salmon-milk ration these feeds supplied equal amounts of protein. There was no difference at a level of 5% protein (from supplements) but at higher levels of 7.5 and 10% of protein the chicks fed salmon and milk grew more rapidly than the chicks fed salmon only. The difference in weight was greater at the highest protein level. These results indicate that milk and salmon have a supplementary value when fed at such a level as to supply 7.5 to 10% of protein.

The chicks that received 7.5% of protein from the supplements (salmon or salmon and dried skim milk) weighed significantly more at eight weeks than the chicks fed rations containing only 5% of protein from these supplements. Increasing the amount of protein supplied by salmon only from 7.5 to 10% did not increase the rate of growth, but a similar increase in the rations where both salmon and dried skim milk were fed increased the weight attained at eight weeks. The average weight at eight weeks was as follows: salmon only, 10%—558 grams, 7.5%—558 grams, 5%—502 grams; salmon and dried skim milk, 10%—676 grams, 7.5%—619 grams, 5%—478 grams.

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CURRENT PUBLICATIONS

CHEMICAL AND MICROBIOLOGICAL FACTORS IN SOME QUEBEC SOILS. By R. R. McKibbin and P. H. H. Gray, Assistant Professor of Chemistry and Assistant Professor of Bacteriology respectively, Macdonald College, P.Q. Contribution from the Faculty of Agriculture of McGill University, Macdonald College, P.Q., with financial assistance from the National Research Council of Canada. Macdonald College Journal Series No. 16. Canadian Journal of Research, 7:3; 300-327. September, 1932.

The major soil groups in a large area of agricultural Quebec have been defined and the primary factors effecting differentiation studied. Organic-matter relations as well as the variations in mineral colloidal matter have determined the groupings adopted. Eight major soil groups are named; *viz.*, heavy clay, sandy clay, lowland podsol, upland podsol, brown earth, orchard soil, lowland muck swamp and upland muck swamp Chemical and microbiological studies of representative virgin soils within each of the first-named six groups are reported, and field data presented.

QUEBEC ORCHARD SPRAY SERVICE[1]

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INTRODUCTION

The Quebec orchard spray service was inaugurated in the spring of the year 1929 by the Provincial Department of Agriculture through its Bureau of Protection of Plants which is directed by Mr. George Maheux, Provincial Entomologist. This service consists in advising each grower by letter as to the proper time for spray applications. Such work was undertaken by special request of the growers themselves through their Pomological Society. The main reason for such a move was the failure to get satisfactory results with the spraying programme then in use. In 1929, Mr. George Maheux, Prof. J. G. Coulson and Mr. C. E. Petch, Entomologist-in-charge of the Federal Laboratory at Hemmingford, Que., acted as directors of the service. Two assistants, Mr. F. L. Godbout and Mr. E. Lavallee did the field work. Last year the organisation and general direction of work was under Mr. Fernand L. Godbout, assisted by Mr. E. Lavallee, and the information relative to orchard insects was given by Mr. C. E. Petch. Professor Coulson acted in an advisory capacity. The same men excepting Mr. E. Lavallee are on the service this year.

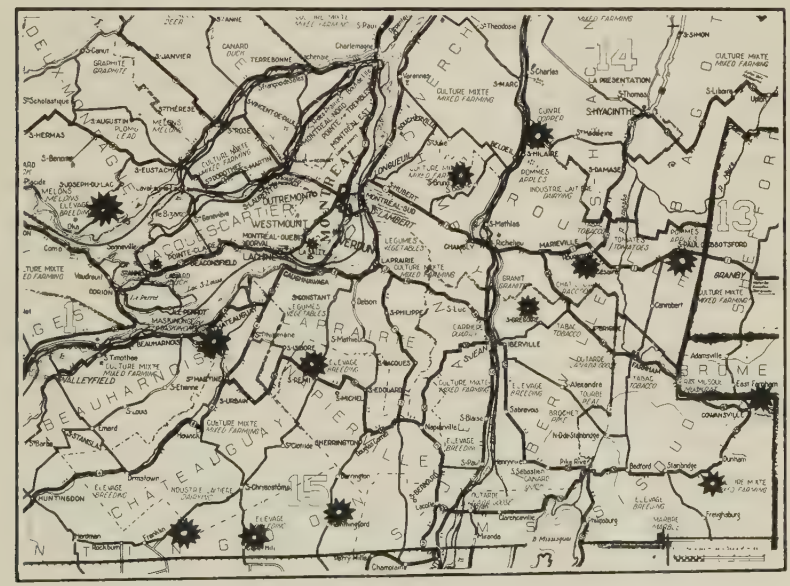

Figure 1. Location of the various orchard districts in Quebec indicated by stars.

[1] Paper read before the Canadian Phytopathological Society, Guelph, Ontario, June, 1931.
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Area Covered, Varieties Involved and Number of Growers

Most of the orchards which are sprayed according to this advice are grouped in several scattered districts covering about 2,700 square miles (see Figure 1). As is to be expected orchards in such widely separated districts show a marked difference in their seasonal development, and this adds greatly to the difficulty connected with the efficient operation of the service. The main varieties grown are the Wealthy, Duchess, Fameuse and McIntosh. These last two varieties form the largest proportion of the apple trees. The membership in 1929 was 114, in 1930, 151 and this year there are nearly 300. This number is expected to increase again next year. During the first two years a membership fee of two dollars was charged but now this service is given free to all growers requesting assistance.

Basis and Methods of Giving Spray Notices

The information supplied to the growers is based upon a study of the development of insects and the apple scab fungus, as well as on the state of the trees and the weather conditions. The first spray is based upon the time of maturing of the perithecia and ascospores of the scab fungus. Such information is secured through numerous microscopical examinations of perithecia on old leaves which are collected at two or three day intervals in various representative orchards of each apple growing district. In a case where the period between the application of the first spray and the arrival of the "pink bud" stage is long and wet, we advise a pre-pink spray. Such conditions occurred in 1929 and this present spring. The pink and calyx applications are, of course, standard and so are always advised. The timing of these two sprays is done by the growers themselves. The two summer sprays are timed according to weather conditions and, in some regions, one or two sprays are advised for the control of the apple maggot. These come in July (12-15) and the beginning of August. Finally, a late spray is recommended for those orchards where a certain amount of scab is found, in order to prevent pin-head infections. This spray generally is applied towards the end of August. This makes altogether six or nine sprays depending on the season. Along with the spray service notices are sent special timely recommendations and general information in connection with spray machinery, methods of spraying, materials, etc. The growers are also supplied with a Spray Calendar from which they can secure advise and information on orchard spraying. Spray notices are sent in the form of mimeographed letters to individual growers. It takes from six to nineteen hours for these letters to reach the growers. We find this system rapid enough.

During the seasons of 1929-30 we were supplied with one and two day weather forecasts from Toronto, Ont. The rain predictions were not altogether reliable in early spring, but on the whole the forecasts were found useful.

Results of Ascospore Discharge Studies

Season of 1929.—In 1929 spore traps were established in twelve different orchards. These were chosen as being typical of the districts and convenient for the purpose of study. The slides from each spore trap were collected and replaced every 24 hours excepting Sundays, from April 27 to June 13. By

that time ascospore discharge had become very slight and for this reason the slides were collected every 72 hours until July 2, when spore discharge seemed to be complete. However, the traps at Macdonald Col'ege and Hemmingford were kept in operation somewhat longer to be certain of following this to completion at least in two orchards. The results are given in Table 1. From this table it is seen that there was considerable variation in time and number of discharges in the various districts, and even in two orchards of the same district.

TABLE 1.—*Record of ascospore discharge for 1929.*

District	Orchard	Number of spore discharges	First spore discharge	Last spore discharge
St. Hilaire	Jackson	9	May 11	June 17
St. Hilaire	Noiseaux	12	May 2	June 17
Mt. St. Gregoire	Desmarais	8	May 14	June 17
Rougemont	Paquette	10	May 7	June 16
Abbotsford	Chaplin	9	May 7	June 15
Abbotsford	Cote	8	May 3	June 18
Hemmingford	Petch	12	May 2	June 30
Chateauguay	Jack	7	May 20	June 18
Macdonald College	College	7	May 15	June 18
Ville La Salle	Newman	5	May 15	June 16
Oka	Agric. College	3	May 14	June 8
St. Joseph Du Lac	Labelle	5	May 17	June 14

The periods of heaviest spore discharges in all regions, excepting Hemmingford, occurred from about the middle of May till the tenth of June. In terms of the apple tree development, this period occurred approximately from the pre-pink stage until a few days after the calyx stage. In the Hemmingford district, which is the farthest south of all, this period occurred a few days earlier, that is, from the beginning of May till the 5th of June, or from the green-tip stage until the calyx stage.

Season of 1930.—In 1930, spore traps were established in nine different districts. Each orchard in which they were placed was known to have been infested by scab in 1929. The selection was made so that we could find a good supply of leaves bearing perithecia, enabling us to easily follow spore discharges. The slides from each spore trap were collected and replaced at irregular intervals according to weather conditions and length of exposure. From May 1 to June 26, there were sixteen collections made. The first ascospore discharge was noticed on May 2 and 3. The buds in a few trees were just starting to swell and it was not thought necessary to advise any spray at that time. During the season there was practically no variation between the number and periodicity of spore discharges for each district. Around June 23 important spore discharges were over as only traces of spores were found on slides exposed to leaves during heavy rains. The period of heaviest spore discharge in every district occurred during the last half of May. In terms of apple tree development, this period occurred from the pink bud stage until four or six days after the calyx stage.

Season 1931.—This spring, the first mature perithecia were found around April 22. The fruit buds were then in the advanced mouse-ear stage.

Rain occurring on April 26, 27 and 28 resulted in the first ascospore discharge. Subsequent spore discharges occurred infrequently but were very heavy, and ascospore discharges was practically completed early in June.

Notes on Epidemiology

In our work it has been noticed that those leaves which developed the largest number of perithecia were generally those that were infected late in the previous fall. Each season each ascospore discharge was correlated with rainfall, air, temperature and relative humidity. Spore discharge occurred under low as well as high temperatures and only when the leaves were wet with rain. Sepal infections were observed in 1929-30-31. In some cases the damage was very considerable. This shows that in our conditions, the sprays applied before the blossoming period are of great importance. In the early stages of leaf development we find the under surface to be commonly the first affected. Late infections have occurred each fall in different degrees according to the amount of rain. In 1929 such infections were particularly prevalent in orchards alongside the St. Lawrence river. Then in order of importance came the districts around the mountains and finally around Hemmingford. Under our conditions, the McIntosh apple is the most susceptible to scab and is specially subject to late or "pin-head" infections. Fameuse comes next in susceptibility. Wealthy and Duchess are generally free of scab. In a spring of favourable scab weather these last two varieties will become affected, unless sufficient sprays are applied.

Methods of Obtaining Data from Growers

In order to obtain the maximum efficiency of this service, we undoubtedly need to gather as much data from each grower as possible, including size of orchard, varieties, mode of orchard planting, and details relative to spray equipment, kind and quantity of material used, methods of spraying, etc. To secure this the members were visited at the end of the season of 1929 and were asked to answer a specially prepared questionnaire. A good deal of difficulty was experienced in many cases in obtaining satisfactory replies due to the lack of knowledge on the part of the growers concerning details. In many cases the grower did not know the acreage of his orchard or the number and age of his trees. However, the report revealed that the majority of the members use the spray gun in preference to the rod and that there are seven time as many guns as rods in use. The pressure used was generally over 200 pounds, although a number gave figures as high as 350 and sometimes 400 pounds. Most growers claim they use as fine a mist as possible and endeavour to obtain what they consider to be a good coverage. Last year (1930) a new system was inaugurated in order to gather more data. Detachable cards were sent along with each spray notice to be used for filling in answers to certain questions on which information was sought, the cards to be mailed after each spray. Unfortunately, only 34% of these were returned and this system was dropped. This year, we distributed to most growers a special spray record card. Besides certain details relative to spray materials, time of application and equipment, information was sought concerning cost of spraying. This seems to interest most of the intelligent growers and we hope to have better success with this system.

Results Obtained, Causes of Failure

The results obtained in 1929 were satisfactory and encouraging, especially if we consider that the spring and early summer were unusually wet and cool, causing the trees to develop slowly thus favouring the discharge of ascospores and development of scab. Moreover, heavy rains occurring just previous to picking time brought about heavy late infections in some of the orchards in two districts. During that season all unsprayed or badly sprayed orchards were heavily scabbed, sometimes up to 100%.

At the end of the season a very definite effort was made to obtain the percentage of scab infection on leaves and fruits particularly of the McIntosh, Fameuse and Wealthy varieties for each orchard, and to secure from the grower an estimate of the amount of scab present in comparison with the previous year.

Table 2.—*Summary of scab infection for 1929.*

1. Scab on fruits—		
4	orchards	Traces
19	"	1-2%
30	"	2-5
15	"	5-10
13	"	10-20
7	"	25-80
2. Scab on leaves—		
50	orchards	Traces
24	"	1-5%
8	"	5-10
2	"	15-20
1	"	50
3. Comparison with past years—		
1	grower reports	More scab
18	growers report	About same amount
10	" "	5% less
13	" "	10 "
4	" "	15-20 "
19	" "	25-35 "
10	" "	40-50 "
10	" "	70-80 "

Table 2 gives the percentage of scab on fruit and leaves for the varieties Fameuse and McIntosh grouped together and also the estimates of the growers relative to the amount of scab in 1929 as compared to the previous year. Here it is necessary to mention that the orchards where heaviest infection on fruit and leaves was found are mainly situated in districts where late infections occurred and invariably in orchards where the last spray recommended was not applied. It is also interesting to note that growers who reported about the same amount of scab as in previous years are generally those who had been doing careful and quite adequate spraying for several years, and the contrary was almost invariably true for those reporting a large decrease.

The season of 1930, considered as a whole, was again favourable for the development of scab and other orchard pests in general. Nearly every spray application was delayed a few days on account of continuous rains.

Orchards which were not sprayed were again heavily scabbed. The percentage of scab infections on the McIntosh and Fameuse apples for each orchard is given in Table 3. It will be seen that the number of McIntosh orchards with over 10% infection were more numerous than was the case in Fameuse orchards. Similar observations were made last year, which further indicate that the first variety is more susceptible than the second. A comparison of the amount of scab observed in 1930 with that observed in 1929 showed that 64% of the growers reported no change in the percentage of scab infection, that 15% of the growers noticed a decrease of 5% to 30%, and that 24% of the growers reported increases varying from 10% to 30%. In this last group of orchards we have generally discovered one or more causes which tend to explain such increases. These will be mentioned later. In making detailed comparison along the same line, we find that in the case of those orchards where less than 10% scab was observed in 1929 only 6% were reported to be slightly more scabby in 1930, about 13% being less scabby and the remaining 81% showing the same amount of scab. In other words, increases in scab occurred essentially in the orchards which showed considerable infection the previous year and which were in the hands of the poorer growers. Herein lies the particular value of the visits to growers. Very often in talking to the grower he is able to indicate the cause of his failure, or the reasons may be explained to him after certain details have been obtained.

TABLE 3.—*Summarized data on scab infection of the varieties McIntosh and Fameuse,* 1930.

Amount of scab	Varieties	
	McIntosh	Fameuse
Traces	12 orchards	14 orchards
1 – 2%	13	13
2 – 5	25	24
5 – 10	16	26
10 – 20	12	10
20 – 40	20	16
40 – 80	10	6

Considering the very adverse conditions in which sprays were applied in 1930 the results were gratifying. It has been commonly observed that the less scab there is in the orchard by the end of the season, the easier it will be to control scab the following season. This year we have had indications that the scab control will be quite satisfactory. In those orchards where one or more sprays were missed we find considerable scab on the leaves and in many cases on young fruits, while neglected orchards show very heavy infections.

The preceeding results show that scab control is not yet entirely satisfactory in every orchard. It is certain that adverse weather conditions constitute a most important factor which determines the severity of occurrence of the disease and increases the difficulty of its control, but besides these natural and uncontrollable factors we have found others which would explain present failures in controlling scab. Lack of thoroughness is the main one. Very often the top or centre of trees and the tips of branches have been

missed. In some cases trees have been sprayed on one side only. An inquiry made in the fall of 1929 on the quantity of spray material used for spraying trees of various ages has shown that many growers do not use adequate amounts. Since then, much improvement has been accomplished through an educational campaign. Some growers generally neglect spraying "non susceptible" varieties or non-bearing trees, whether they are old or young. In some orchards the trees are too crowded; under such conditions, there is a lack of aeration,and in addition thorough spraying is practically impossible. Growers at times neglect to spray wild trees along the fence rows. This naturally increases their difficulties in obtaining satisfactory control. Due to neglect in preparing the spray machine early in the spring it often happens that the first and the second sprays are missed altogether. Sometimes, the summer sprays are not applied, for the sake of saving the hay or because of some other crop in the orchard. We have found that this practice does not pay. Finally, many growers need spraying equipment more suitable to the size of their orchards. Through orchard visits, demonstrations, letters of advice and group lectures, the officers of the spray service and the Instructors in Pomiculture are aiming to improve the situation.

Other Investigations

Along with the Spray Service work we conduct thorough surveys in all orchard growing districts in order to know definitely the size, location and the conditions of every single orchard and to adjust our methods of extension work and spraying recommendations accordingly. Apple pressure tests were started last fall with the object of determining the most suitable time for harvesting McIntosh and Fameuse varieties in order to obtain the best storage quality. Advice is given to growers concerning other diseases and pests such as fire blight, collar rots, crown gall, cankers, destructive insects, etc. Each year a record of the weather is kept. This includes rainfall, sunshine, humidity and temperature. It is hoped that in time sufficient data will have been collected to be of use in a study of epidemiology. The years under review can be taken as a real test for this spray service since apple scab infection has been severe on all unsprayed susceptible varieties in each district involved. The service has undoubtedly been a success, as most of the growers of the Montreal district spray according to the notices and have indicated their desire for its continuance. Many orchards have been turned into profitable ones, the owners of such orchards now being the strongest supporters of the service. The attempt has proven of great educational value and stimulation to growers, and has resulted in most cases in greater attention to spraying details and better results. The results obtained indicate that a properly organized spray service may prove of great value to the fruit growers and can be operated successfully in any district in spite of the difficulties encountered in dealing with a widely scattered group of growers.

APPLE ORCHARD SPRAY SERVICE IN ONTARIO[1]

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The author has chosen this subject for a paper with a twofold purpose in view, first to acquaint as many plant pathologists as possible with the nature and extent of this service, and secondly to illustrate what the application of scientific knowledge in plant pathology and entomology has accomplished in solving some of the most difficult problems of the practical orchardist. I refer, of course, to the control of the fungus and insect pests of the orchard.

There are two spray services in the province, one for the Niagara district which includes tender fruits, and another for the rest of the province concerned chiefly with apples, though other fruits are not neglected. These services are both financed entirely by the province. The one in the Niagara district is under the general supervision of the director of the Vineland Horticultural Experiment Station in co-operation with Mr. W. A. Ross, Advising Entomologist, and Mr. G. C. Chamberlain, Advising Plant Pathologist, two officials of the Dominion Department of Agriculture. The other service which includes the rest of the apple growing sections of the province is supervised by Professor L. Caesar and myself. This paper will deal with the province-wide spray service only.

Origin of the Service

Other branches of farming being more profitable during and immediately after the World War, apple growing was for a time largely neglected. In a few years, however, there was a great decline in the price of livestock and grain. The result was that by 1924 many men with orchards determined to give them the care and attention they required to make them profitable once more. These men realized that if their orchards were to give returns in dollars and cents, fungus and insect pests must be controlled. It was obvious to most of them that it would be of little use to prune, fertilize, and cultivate their orchards if fruit free from insect and fungus blemishes could not be produced. They therefore turned their attention to the production of clean fruit and were eager for information concerning spraying. It was the psychological moment to adopt new and more effective methods of raising the standard of spraying in the orchards of the province.

This was realized by Professor Caesar and he started the province-wide spray service in 1924. Eight orchards only were in the spray service that year and Professor Caesar personally supervised the work in them. The suggestion for a spray service came from New York State, but ours is not modelled on theirs or any other. It has been worked out step by step by ourselves to suit Ontario conditions.

Growth of the Service

The results obtained in the eight orchards in 1924 were so conspicuously satisfactory that in 1925 fruit growers in nearly all the nearby districts asked

[1] Paper read before the Canadian Phytopathological Society, Guelph, Ontario, June, 1931.
[2] Professor of Botany.

for the service. In 1926 there was a request for further extension and in each successive year the service has steadily grown. This year (1931) the work was carried on in twenty-four counties of the province, so that the service now includes almost every apple growing district in the province and the great majority of commercial orchards. It started, as has been stated, before, with eight orchards in 1924. This year 1374 orchards were supervised. These do not include the orchards in the Niagara Peninsula.

Organization

This service is under the personal supervision of Professor Caesar and myself. All the members of my department aid me in this work when I require assistance. At the present time fifteen local supervisors assist us with this work. There is usually one supervisor for each county though Norfolk and Prince Edward have two, and in some cases one supervisor looks after parts of two or more counties. Professor Caesar and I decide what spray mixtures shall be used, how many applications shall be given, and what time these shall be made. The local supervisors are the men who look after the details of the actual spray work among the growers. Professor Caesar and I divide the work between us and endeavor to visit each local supervisor as often as we can to help him with any problems that may arise, and see how the work is progressing. The agricultural representatives in the various fruit districts heartily co-operate in this work. They give their aid and that of their stenographers to the supervisors. In fact they look after the business end of the service, and the spray supervisor is required to consult them in all matters of special importance. The director of the Fruit Branch at Toronto, and the Horticulture Department of the O.A.C., Guelph, also give the service their hearty co-operation. All expenses are paid by the Provincial Fruit Branch.

Training of the Local Supervisors

The best men available are chosen for this work. We try to secure supervisors who have a background of practical orchard experience and who are graduates of an agricultural college. We try to create in them a love for their work and a keen sense of its importance to the fruit industry of the Province. These men and the agricultural representatives in their respective counties, attend each year a special short course either at the Ontario Agricultural College or in some other suitable centre. This course includes special lectures in insect and disease control, information about new spray mixtures, lectures on fertilizers, and orchard management, information concerning the best varieties of apples, and all the more important aspects of apple growing. These lectures are supplemented by practice in such orchard operations as spraying, pruning and grafting, and by the inspection of the latest spray machines, dusters, and other orchard equipment. Our aim is to have our supervisors well informed in all the aspects of fruit growing as well as spraying. These short courses serve to keep these men up to date and to inspire them with a greater interest in their work, thus making them of more value to the growers whom they serve.

Requirements for Entering the Spray Service

The service is free. Any grower may enter it. All that he has to do is to send his name to the agricultural representative in his county and agree

to follow the directions of the local spray supervisor. He is required to have adequate spray machinery, to properly take care of his orchard, and to order in good time the necessary spray materials recommended by his supervisor. If he does not agree to these conditions the supervisor will not undertake to visit him and superintend his spraying operations. The supervisor will however, gladly give him any information available by mail or telephone.

The Work of the Local Supervisor

The local supervisor instructs the grower as to what spray materials he should use and the approximate amount of these he will require. He also notifies the grower when each application should be made and superintends his spraying operations. It is the supervisors' duty to point out to the grower any faults in the methods of his spraying, and suggest means of doing the work more thoroughly or more rapidly. In brief, he endeavors to get the grower to protect his trees from fungi and insects in the most effective and economical way.

The Timing of Applications

Correct timing is probably the most important factor in successful spraying. It is no easy task to time each application so that it will do the most good. Our experience is that the first or pre-pink spray is the hardest one to time correctly. Our general directions for the timing fo this application are as follows: "Commence spraying as soon as the fruit buds on most varieties have clearly burst. Try to cover two-thirds of each tree from the one side at this stage. Spray the other side as soon as the cluster bud stage has been reached and again try to cover two-thirds of each tree." The results obtained in the prevention of early infections by the apple scab fungus, and observations on the discharge of the ascospores of the scab fungus, would indicate that this is the correct time for the first spray.

Every year each spray supervisor sends in each week old apple leaves from the orchards in his county. These we examine under a microscope and record the development of the ascospores of the scab fungus. We have thus been able to determine approximately the time that the first ascospores were discharged in each county each year. It is interesting to compare the date the first spray was given with that on which the first recorded ascospore

Table 1.—*Comparison of date of first spraying with date of first ascospore discharge.*

County	Date of first spray	First recorded ascospore discharge
Norfolk	April 21	April 22
Huron	" 21	May 9
Northumberland	" 22	" 9
Lambton	" 24	" 1
Brant	" 21-24	" 16
Halton	" 29-May 17	April 29
Prince Edward	" 22	" 27
Elgin	" 20	" 27
Middlesex	" 23	May 4
Gray	May 4-11	" 20
Durham	April 21	April 29
Dundas	" 24-25	May 16

discharge took place this year in the counties of which we have records (Table 1).

The time of applying the first spray was in every instance determined by the development of the buds. The above comparison would indicate that applying the first spray at the stages of bud development previously described should give protection against the early discharged ascospores and thus prevent early infections of the young leaves and calyx tips.

Results Obtained

It is very difficult to get definite and reliable figures of the benefits of this service to our growers. In order to get some idea of what was actually being accomplished in the various counties I asked the agricultural representatives and the spray supervisors to furnish me with as exact information as possible about the results being obtained in their respective counties. Time will not permit of dealing with these reports in detail, but they bear striking evidence that the service is doing much to improve orchard conditions in Ontario

Each fall I have had an opportunity of seeing the results of the spray service and I am convinced that the average percentage of clean fruit in our orchards has been more than doubled. It is true that there are some men in the service who have dirty fruit but there is always a good explanation for such, which the men themselves usually understand and appreciate as a guide for next year's work.

In conclusion I wish to acknowledge with thanks the information provided by the agricultural representatives and spray supervisors which has made possible the presentation of this paper.

A PROJECT IN THE USE OF GROUP CONCIOUSNESS AS A LEVER IN AGRICULTURAL PROGRESS[1]

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Pioneer communities develop their agriculture largely by trial and error experiment and imitation stimulated or driven by economic demand, without much regard to research, scientific management or method. It is avowedly the object of extension activities to make available easily assimilated, up-to-date knowledge, to cultivate skills, and to give direction to production in such a way as to reduce for the pioneer the hazards of the supreme gamble of his life and capital against the forces of nature, and to place a few sign posts to guide him in his isolation from the market places of the world where the products of his labor meet bewildering changes of taste and fashion.

It is unnecessary to deal with the net-work of organization we have built up in Western Canada to bring our farmers within the sweep of world demand for their products. Within the past quarter of a century, in particular, since the Provinces of Saskatchewan and Alberta were formed, we have created Schools of Agriculture, Experimental Farms, Illustration Stations and established Departments of Agriculture, which now spend annually in the three Prairie Provinces approximately one million dollars while the Dominion Department of Agriculture in 1930 spent over nine million dollars throughout Canada. Furthermore we have built up Provincial educational systems costing us over forty-five million dollars annually. The rural school staffed by country minded teachers should be the natural ally in any campaign of improvement in maintenance of standards and in the dissemination or collection of information. But it will be agreed that as an institution it has not been a marked force in agricultural development. Its heavy task has been to create a literate population and to provide a limited number of candidates for higher education. The narrow gateway of our High School and University entrance examinations has restricted the curriculum and methods of the rural school and given it an urban bias which, perhaps, is a reflection of the demands of parents not quite reconciled to the surrender of their children to an occupation toilsome and hazardous.

The Departments and Schools of Agriculture have thus found it necessary to undertake extension activities on a wide scale without being able to rely much on the assistance of the teaching personnel of our rural schools. Sir Herbert Tree once admonished an actor whose rôle it was to carry a lighted candle across the stage of His Majesty's Theatre, not to forget the 5,000 candle power electric light turned upon his act and the expense involved to the management. The farmer with his modest establishment burdened with obligations is now doing his work against a back-stage of agricultural administration, and his effort is now seen in a battery of light involving an expensive paraphernalia of scientific research and guidance. This involves a great change from the day when his success or failure was carried on in obscurity. Yet the results can hardly be called satisfactory.

[1]A paper read before the Twelfth Annual Convention of The Canadian Society of Technical Agriculturists at the Manitoba Agricultural College, Winnipeg, Man., June 15, 1932.

[2]Western Manager, Department of Colonization and Agriculture.

Apart from the question of great distances and pioneer conditions retarding progress, there are gaps in understanding, resulting from the wide variety in the racial material with which our Prairie Provinces, in particular, have been settled. The 1926 census shows that in Manitoba, Saskatchewan and Alberta, are to be found nearly 140,000 Scandinavians, 270,000 of Germanic folk, counting Dutch, German and Austrian and 280,000 of Slavic origin. Over 75% of these people live on the land and a much larger proportion of the young people under 21 of Slav, Scandinavian and German stock remain on the land than of Anglo-Saxon stock. The barriers of language, race and creed have intervened to make the work of interesting these groups in better methods slower. In 1922, as a result of a survey made through teachers in non-English communities in rural Saskatchewan, it was found that though there was innate love of the soil, gardening skill, thrift, a self-contained and simple (though not necessarily lower) standard of living—all qualities useful to us when our economic structure is being shaken by depression—there was lack of appreciation of the value of good stock and pure seed, and an inability, reluctance or timidity in availing themselves of the services, advice and direction given by our provincial institutions The results of this survey are summarized on pages 74 and 75 of "The Central European Immigrant in Canada." The questionnaire used is to be found in appendix "B" of the same volume. To the critically minded I ought to say that I had not the benefit then of technical assistance, as in the period immediately following the war, we had no extension service worker in agriculture in what was an Ukrainian and hence a franchiseless district, nor had we the refinement of statistical methods underlying a survey such as that now undertaken by the Pioneer Belt Survey committee. It is only fair to say that immediately before the war, I can recall little actual contact between individual farms and Departments and Schools of Agriculture, which were just beginning theirwork. The District representative is a development in Western Canada within the last few years. Furthermore, the non-English settler had taken up land in the park country where much clearing had to be done and agricultural development was hardly at the stage to profit by guidance.

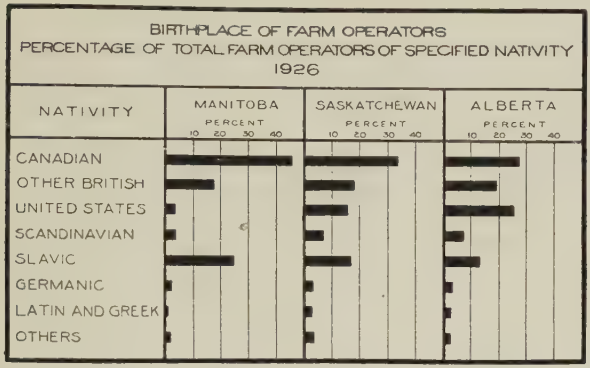

Figure 1. In 1926, 34.1 per cent of the farms in the prairie region were operated by native Canadians; 31.2 per cent by continental Europeans; 18.5 per cent by other British born; and 15.7 per cent by United States born farm operators. Graph used by courtesy of the Dominion Bureau of Statistics from their publication, Agriculture, Climate and Population of the Prairie Provinces of Canada, by W. Burton Hurd and T. W. Grindley.

We have had, as a railway, an example of this in another form in our territory from Prince George to Hazelton in British Columbia, where fishing, mining, lumbering and railroad construction provided settlers with work on railway and road and in provision of ties. But with more land cleared and

the decline in demand for ties, etc., we have found that greater attention has been paid to farming *per se*. Our representative at Prince George has succeeded in interesting communities in this territory in better stock, forage crops and better seed—but this is another story.

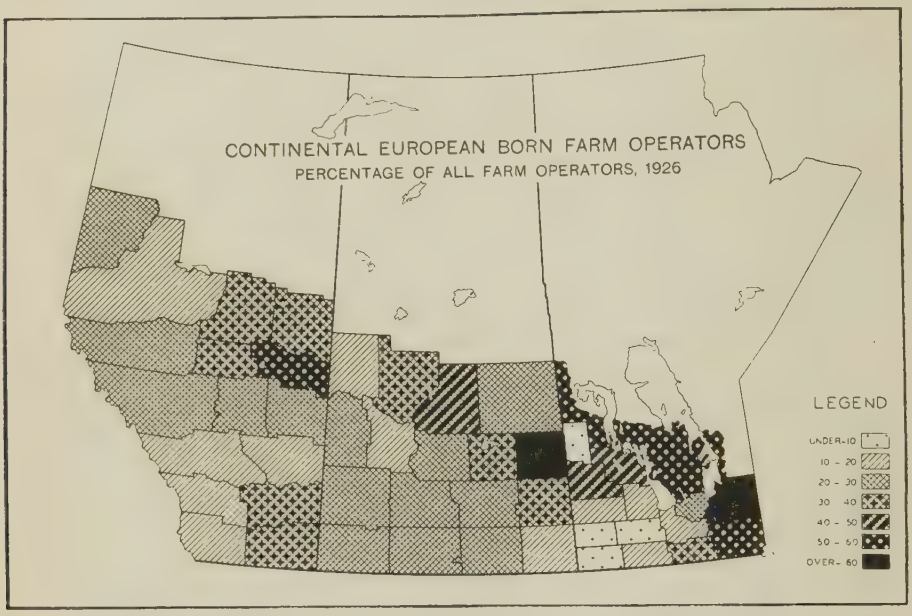

Figure 2. Percentage of all farm operators born in continental Europe according to 1926 census. Graph used by courtesy of the Dominion Bureau of Statistics from their publication, Agriculture, Climate and Population of the Prairie Provinces of Canada, by W. Burton Hurd and T. W. Grindley.

In any case the difficulty of making contacts with a non-English community in the years immediately after the war, led some of us to believe that racial group settlements were undesirable and such settlements became suspect as being subversive of national unity and unprogressive in agriculture. Contacts were difficult to establish. Early in 1930, Dr. W. J. Black who has been associated for so many years with agricultural work in Western Canada, canvassed the situation as to whether a plan of community competitions could be developed to bring within the sweep of our Canadian culture and life, the traditional skills, homecraft and handicrafts of our European peoples and to interest them in the services provided by our Provincial Institutions in education, health and agriculture. As a result, the competition was inaugurated in 1930, and prizes made available for districts who had made the most satisfactory progress according to the score card arranged.

You will observe from the regulations and score card (Tables 1 and 2), that the communities eligible are those having a resident population showing 70% of Continental European origin, first or second generation. The community unit is the rural municipality wherever practicable or desirable. Units smaller than municipalities consisting of five or more school districts adjacent one to the other are also eligible. This provision was made to cover smaller racial groups. The score card was prepared after careful consideration

and discussion with the Departments of Education, Agriculture and Public Health, in the three Western Provinces. In the allotting of points, stress has been laid on community co-operation and organization and as you will observe, the points awarded under agricultural development, stress relatively simple objectives and emphasize quality of product, saying nothing of quantity. The standardized, simplified score card has the advantage that over a period of years, it becomes well known to community leaders and teachers throughout the districts concerned. Two ideas which are normally considered as conflicting are woven into the texture of the project. First, co-operation in the community is stressed, and secondly, competition as between communities and not between individuals. No attempt was made to make the score card a scientific survey as, I think, it will be agreed that the defect of the survey method lies largely in the ease with which carefully gathered information can be neglected.

The score card here is, therefore, a weapon, and such surveys as are necessary in the process of scoring are carried out with definite objectives. The guiding principles are co-operation within the community, comparison of community achievement and standards with other communities, and competition to reach objectives as precisely and simply stated as possible.

May I emphasize a few *principles* which are axiomatic. From the *psychological* angle a community is the natural and most effective medium for the inoculation of ideas through the force of mass suggestion and imitation. The influence of the community 'mores' and group consciousness is of greater weight on the minds of the adolescent than family opinion. It is essential to enlist the underlying racial, religious or cultural motive force in favor of the programme. Appreciations, attitudes and perspectives are often more important in determining the drift of a community towards progress or decadence, than knowledge. Sentiments, beliefs and ideals grow as a result of group consciousness, which often in its perceptions lags behind what knowledge would dictate to be sound policy, practice or judgment. That the emotional attitude, determined in the main by group consciousness, whether it be racial, religious, cultural or national, is more powerful throughout the world for good or ill than erudition, is proved by the fact that despite almost unanimous considered opinion as to the necessity of breaking down trade barriers and of disarmament, we have singularly failed to make progress in reaching either of these objectives. Our schools have not succeeded in having us avoid the temperamental traps into which we are perpetually being led by our innate pugnacities and irrationalisms. Cruelties, ferocities, massacres, misrepresentation, are considered by us as so many examples of the wickedness of peoples different from ourselves, instead of sign posts marking "dangers" into which we may run.

From the *economic* angle, very little can be done with regard to argicultural progress unless the whole community shares in the effort. It is a commonplace that the same breed of cattle throughout a district makes herd improvement work simpler and conduces to uniformity in shipments and makes possible the pure bred sire area, the T. B. free area and Cow Testing associations. Weed and pest control are community problems. Marketing and purchasing co-operatively can only be effected by community effort. The strength of community spirit in a pioneer district is its salvation. In

Regulations Governing Competitions

1. Three prizes will be available in each province for the year 1932, as follows:

1st	$1000
2nd	$ 500
3rd	$ 250

2. The scope of the competitions will be province-wide in each of the three provinces mentioned. The area which shall constitute the community unit for competitive purposes will be the rural municipality wherever practicable and desirable. An alternative unit, however, consisting of five or more school districts adjacent one to the other, thus constituting a community, will be considered eligible. In order to enter the competition communities must have a resident population showing 70% of Continental European origin, first or second generation.

3. Units smaller than municipalities, owing to their voluntary basis, will be expected to show a higher standard than the fixed municipal units, at the discretion of the judges.

4. Entry application forms may be obtained from the Departments of Colonization and Agriculture, Canadian National Railways, Room 100, Union Station, Winnipeg, Man. These should be filled in and forwarded to this address, by the secretary-treasurer of the rural municipality or by the secretary of a recognized community organization desiring to compete. All entries for 1932 must be forwarded to the above address not later than April 30, 1932.

5. There will be a board of judges for each Province, whose decisions in the awarding of the prizes will be final.

6. The judges may use their discretion in taking into account the length of time a district has been settled, soil and location, and any special work done during the year.

7. The prizes will be awarded at the end of the calendar year and the purposes to which they will be devoted will be decided by consultation between the Communities concerned and representatives of the Canadian National Railways. Approved projects may, for example, be a community library, construction or equipment of a community hall, support of community hospital or public health nurse, beautification of schools, or some such permanent development of a community's activities.

8. Communities winning first prize shall not be eligible for competition during the following two years. It is hoped however, in the final year of the competitions, to have a special competition for all first prize winning communities, for which a grand championship award will be made.

9. If considered in the best interests of the community winning any of the three prizes offered, the prize money may be divided among the several school districts which may be included in the competing community.

10. Questionnaires asking for progress made during the year will be sent to secretaries of entries, as information now compiled, covering districts entered during the past two years, is comprehensive. After preliminary scoring by representatives of the Railway or officials of the Provincial Departments, a selection will be made of a limited number of communities which, in the opinion of the judges, should be visited by them.

11. The regulations as set forth herein are not to be considered in any way arbitrary for competitions of future years, since these may be changed to suit conditions in the light of experience gained.

For information concerning the Competitions, address Robert England, Western Manager Depts. Colonization and Agriculture, C.N.Rys., Room 100, Union Station, Winnipeg, Man.

Table 1.—*Regulations governing competitions.*

Score Card

A. Education (275 Points)

1. Percentage School Attendance	25
2. Percentage attending High Schools, Secondary Schools, Agricultural Colleges, Collegiate Institutes or Universities	50
3. School efficiency—quality of teaching, progress of pupils, efficiency of school boards	75
4. School Grounds, library, equipment, layout, condition of gardens, premises and outhouses, sanitation	100
5. General	25
	275

B. Agricultural Development (275 Points)

1. General plan and appearance of farms, buildings, gardens, water supply, etc.	100
2. Crops—purity of crops, freedom from weeds, practise of approved crop rotation	75
3. Livestock (Horses, Cattle, Swine, Sheep, Poultry):	
(a) Number of head per farm	20
(b) Quality, feeding, management, etc.	25
(c) Quality and use of purebred sires	30
	75
4. General	25
	275

C. Citizenship, Co-operation, Social Welfare (300 Points)

Public Health

1. Evidence of interest in public health (sanitation, immunization and preventive work, hospitalization, education in health)	100

Community Effort and Respect of Law

2. Interest in community enterprises and general development (good roads, public buildings, community recreation centres, etc.) and observance of law and order	30
3. Interest of farmers in co-operative activities	60
4. Percentage of farmers who are members of organizations such as agricultural societies, school fairs, etc.	25

Boys and Girls

5. Percentage of membership in Swine, Calf, Sheep, Grain, Poultry, Bee, Potato, Canning and Dressmaking Clubs, or other boys' and girls' community activities of a constructive character	35
6. Interest shown in school or agricultural fairs	25
7. General	25
	300

D. Arts, Handicraft and Domestic Economy (150 Points)

1. Handicraft (Embroidery, Weaving, Rug-making, Knitting, Basketry, Toy-making, Painting, Pottery, Vegetable dyes, etc.)	60
(a) Useful—clothing and foods	30
(b) Decorative—clothing and house	30
	60
2. Home manufacturing (carpentering, blacksmithing, leather work, rope-making, etc.)	30
3. Interest in cultural activities (dramatic, musical, social, athletic, folk dancing, etc.)	45
4. General	15
	150
Grand Total	1000

Winners 1931 Competitions

In Alberta

First Prize—Lloyd George (Scandinavian).
Second Prize—Montgomery (Scandinavian-German).
Third Prize—Eagle (Ukrainian-Roumanian).
Highly Commended—Liberty (Ukrainian-German-Scandinavian).
Commended—The Pines (Ukrainian).
Commended—Beaver Lake (Ukrainian-Scandinavian).

In Saskatchewan

First Prize—Laird (Mennonite).
Second Prize—Redberry (Ukrainian).
Third Prize—St. Peter (German).
Highly Commended—Warman (Mennonite).
Commended—Round Lake (Scandinavian).
Commended—Bekevar (Hungarian).

In Manitoba

First Prize—Rhineland (Mennonite).
Second Prize—Stuartburn (Ukrainian).
Third Prize—Hanover (Mennonite).
Highly Commended—Sifton (Ukrainian).
Commended—Ethelbert (Ukrainian).

Table 2.—*Score card used for competitions in 1932.*

urban life, the church, the community hall or the school built by voluntary labor, is an unusual phenomenon. Too often material progress destroys the old spirit which formed a "bee" to raise the barn or help a neighbor in misfortune. Now that the very basis on which we have reared this structure, where every piece of work must be for profit, is threatened, it is pertinent to find incentives to effort other than that of profit for the entrepreneur. The setting up then of definite objectives to emphasize quality and voluntary effort is in line with the needs of society, for nothing can prevent a community engaged in low quality work from quarreling about the spoils as time eats into the honor of thieves and corrodes it. Emphasis, therefore, in the score card, is given to quality rather than quantity, voluntary effort on projects that do not call for expenditure, and on handicraft and home manufacturing.

Turning to the *sociological* aspect, it is admitted that there are, in many of these communities, elements alien to modernity. We find patriarchal and ecclesiastical authority, parochialism, attachment to the soil and often an inferiority complex through old political disabilities resulting in ebullient outbursts and primitive methods sanctioned by tradition, but alongside these are peasant crafts and customs, peasant culture and a peasant mother-wit which are worthy of retention. It is essential then that any score card should recognize the good that has been brought to us. It is well to remember that science is not a search for novelty but for truth and has frequently supplied us merely with an adequate reason for some traditional practice or old fashioned culture. To mistake novelty for progress, mechanization for scientific advance, speed for economy of time, standardization for style, is easy. Rural life can only imitate urban standards at its peril. Surveys may reveal that the pioneer can no more be paid for his isolation and hardship than you can pay a man to be shot at. War cannot be made by contract, nor nations built exclusively by balance sheets.

I shall not detain you with a description of the differences between the various communities as you will be familiar with the main differences existing between the various racial stocks we have in Western Canada. I might point out, however, that apart from the racial make-up of these communities it is often found that the religious or some cultural influence may be a determining factor in the community. We have endeavored, therefore, to ally ourselves in the community with the leadership that already exists. It is obvious that in dealing with 22 racial groups, the majority of whom are Ukrainian, Mennonite, Scandinavian, Hungarian and Polish, it is essential to keep in step with the community's cultural lineup.

The constituencies covered by the competitions last year included 15 entries from Manitoba, 31 from Saskatchewan, and 16 from Alberta, making a total of 62 entries. The total European population in these districts was 149,612, of which 4,196 were new settlers who have gone into the districts in question during the past five years. The total number of farms in the entries was 36,393.

The plan of scoring has been to secure from School Inspectors, through the Department of Education, ratings for rural schools; through the Department of Agriculture, as much information as possible as to the districts concerned; through the various national and provincial co-operative institutions, details of their membership and work in these districts and through the

Department of Public Health a rating of public health for the district. A visit is usually made by one of our representatives, often in conjunction with a member of the Department of Agriculture or Education to secure further data. In scoring we have used a five point scale set up as follows:

Ideal	100	
		Excellent—pivot 90 (80-100)
	80	
		Good —pivot 70 (60-79.9)
	60	
Median	50	Average —pivot 50 (40-59.9)
	40	
		Poor —pivot 30 (30-39.9)
	20	
		Very poor—pivot 10
No effort	0	

No attempt was made to make variations within this scale of less than five per cent. The use of this scale standardized objectively re-actions of staff visiting districts, and has given us satisfactory results. A selection having been made of communities on this basis, a final visit by the Boards of Judges in each Province, has been made in August or September. In each Province, a board consisting of three, one of whom is a woman, presided over by Dr. John MacKay in Manitoba, Dr. W. C. Murray in Saskatchewan, and Dr. R. C. Wallace in Alberta, respectively, gave unstinted time and labor voluntarily to visit communities and make the final selection. It has been the custom in most of the communities for the Municipal Council or some community representative to accompany the judges on a tour of farms, schools and community institutions. Community gatherings are held and a display of handicraft and of home manufactured articles and an exhibition of musical and dramatic art staged. The folk dancing in particular at many of these exhibitions, has been notable. Towards the end of the year the Boards of Judges have reviewed all material available and have made their awards. As to results achieved, it would be impossible in the space of this paper to give complete details. Here are some typical notes taken from score books for 1931, of effort made in districts on the basis of the score card.

Vita, Manitoba.—Excellent improvements on two school grounds. 65 farmers obtained certified seed. Eight bull clubs organized. Four farmers growing registered peas, beans and alfalfa, and four Registered wheat. Community recreation ground established. Sheep fair and Poultry Field day held. Two Poultry Clubs and one Garden Club organized. Much increased interest in poultry as a result of Club work. Improvement particularly noted in housing of poultry. Two poultry club fairs and one Garden Club fair held. Two Nutrition Classes organized. Baseball Club organized.

Laird, Saskatchewan.—Encouraging the use of pure bred sires. Obtained 100 pure bred sows with Government Sow Policy. Bull Club formed and supplied with Shorthorn Bulls. Junior Grain Club formed, with a membership of 19 boys, who were supplied with three bushels each of 10B Marquis wheat from which they produced 1,261 bushels this year, which will be available for seed within the Municipality. Exhibited "Agricultural Field Exhibit" at Saskatoon Exhibition, winning first prize. Exhibit included 150 varieties of preserved fruits and vegetables alone, also many samples of grains and grasses. Two Teacher-Parent associations organized. Engaged a Municipal doctor. Interest in beautification of public school grounds by planting trees and flowers. Obtaining literature on agricultural problems from the University.

Redberry, Saskatchewan.—Organized an Agricultural Society. Petitioned Dominion Government for Illustration Farm to be established at Hafford. Oraganized several Swine Clubs. Purchased Municipal Seed Cleaning Plant. Bull Clubs in process of formation. Increased interest in Ladies' Sewing Clubs. Beautification of all school grounds by planting gardens and trees. Two ploughing matches successfully staged. Boy Scout organization being introduced. Handicraft displays being exhibited at Calgary and Regina Summer Fairs. Dr. Arthur Rose, of Hafford, as a result of interest of the people in the competitions, has lectured many times at their request on Health Topics. He has visited a large number of rural schools, instructing pupils on health, measures and has vaccinated and inoculated 520 children.

Warman, Saskatchewan.—Greater interest by school teachers in promoting Community singing competitions. Song festival conducted by Osler Teachers' Local. Sale of handicraft through regular merchandising channels. Greater interest in weed control. Reduction in the number of grade bulls from 156 to nine and replaced by 100 pure bred bulls. Municipality in pure bred sire area since May 1, 1931. T. B. free area and cow testing conducted by Warman Herd Improvement Association. Competition conducted among boys for best wheat plot—100 competitors.

Lloyd George, Alberta.—Exhibited stock at Edmonton Fair. Held agricultural Fair at Camrose. Held school fairs at Camrose and Hay Lakes. U.F.W.A. and Women's Institute had 798 entries of ladies' work at Camrose Agricultural Fair. Set out 38,000 seedling trees. Increased use of grasses and legume seeds.

Eagle, Alberta.—$600.00 spent on weed control. Six weed inspectors employed. Large number of farmers used registered seed. 10 Shorthorn and 5 Hereford bulls placed in Municipa'ity under Federal Bull Loaning policy. Several Shorthorn bulls purchased from Provincial Government. Built new Community Hall, bringing total number of halls in district to six. Held two School Fairs. Seven branches of Alberta Women's Bureau sent exhibits to all large Festivals and Fairs.

An article by Dr. W. C. Murray in the Queen's Quarterly, Winter Number, 1931, covers his visits of 1930 in Saskatchewan and I refer to it here, as it covers some of the features which space forbids dealing with here. One criticism which has been made of many of these communities, is their reluctance to share in the work of outside activities and organizations, provincial and national in scope. I may refer briefly to a few instances where districts

Figure 3. Upper Farm home of Anton Sware near Hay Lakes, Alta. Center, Dancers at Swedish Community Progress Picnic on occasion of judges visit, DuBuc, Sask. Lower, A fine display of handicraft shown in an Ukrainian district of Saskatchewan.

have begun to be conscious of themselves as fitting into the scheme of things in Western Canada. The Saskatoon Exhibition Board instituted last year a closed competition in district field exhibits for communities entered in the competitions. Assistance was given to the districts in preparation and presentation of their exhibits which, displayed under appropriate caption, received much favorable comment, particularly the exhibits of Laird, Bayne, St. Peter and Humboldt.

Eighty or ninety Mennonite farmers from the Gretna-Altona districts, through the co-operation of the Manitoba Provincial Department of Agriculture, spent a day visiting representative farms and herds of livestock in the Carman-Graysville-Rosebank-Roland districts.

The Community Progress Association of Rossburn Municipality, Manitoba, shipped a carload of 771 bags of potatoes as a gift to the Saskatchewan Relief Commission, early in October, and on November 12th, last year, shipped a further contribution of a car containing 400 bags of potatoes to Southern Manitoba. St. Peter's Colony in Saskatchewan, shipped 11 carloads of vegetables and coarse grains and a large quantity of clothing to the drought areas in Southern Saskatchewan. Districts have begun to co-operate with the various handicraft guilds and have put on exhibitions throughout the West. You may be interested in the expenditure of the prize money: in 1930, the prize money was expended for the improvement of Schools, purchase of calves for Boys' and Girls' Calf Clubs, pure bred sires, etc., but I would like to refer briefly to two notable projects. The Municipality of Norma in Alberta, having won first prize, instituted two scholarships each year for ten years, by amortization of the money—one for High School children on a basis of Grade Eight, examination taking into account standing in English Composition, Canadian History and Civics. The second scholarship was for children wishing to attend Agricultural School, one candidate to be nominated from each Township in the Municipality, the winner to be chosen by an appointed committee. The district of Edenwold built an addition to their Community Hall, consisting of a stage and a basement, and established a community library. Two publishing houses, becoming interested in this venture, contributed books which were selected from their catalogues by the Director of Rural Education for Saskatchewan. The district also succeeded in securing a full edition of the Encyclopaedia Britannica and established the beginning of a German Library. The Community Hall having originally been built by voluntary labor and turned over to the village to operate, the village agreed that in return for the addition of a stage, they would contribute $100 for ten years to the Agricultural Society.

It has been very gratifying to find during the past year that very great care has been taken in the expenditure of the prize money. In one case the Laird community decided on the purchase of two Percheron stallions, and in the case of Redberry, on the purchase of six Shorthorn bulls. In Rhineland community, after careful consideration by meetings in the district, the following are the list of objectives to which the money was devoted: (a) Renting of pure bred bulls; (b) Organization of two Junior Seed Growers' Clubs; (c) Purchase of material for five sewing clubs; (d) Organization of two Poultry Clubs; (e) Apportioning an equal amount to five school districts which constituted the entry—the money to be used for improvement of school

building and grounds; (f) Donation to Mennonite Collegiate Institute for purchase of permanent equipment and beautifying grounds.

During the present year it has been pleasing to note the way in which local newspapers have contributed towards keeping up interest in the work, while communities have instituted local competitions for the best farmstead, etc., and by the use of messages to teachers are actively preparing for the visit of the judges.

Here is one letter from the Secretary-Treasurer of a district, received at the end of May:

> "The bush work on farms being almost over, our local Community Progress Competition committee has taken steps to do this and that along community lines. So far it is proposed to:
>
> (1) Have a booth of products at Saskatoon Agricultural Fair in July this year. Mr. W. Martinowich, of Krydor, Sask., undertook to organize and conduct the affair.
>
> (2) We are getting the Imperial Chatauqua (for the first time in the history of Hafford) to put on concerts at Hafford on July 14, 15 and 16. Contract already signed.
>
> (3) A party of local farmers (30 to 35) are organizing to make a one day trip to University of Saskatchewan at Saskatoon in June (any day) to visit Agricultural Department of the University. We are today writing to Extension Department at Saskatoon to ascertain if such a day could be arranged and if they could provide us with a guide who would also explain to the visitors.
>
> (4) A request has been sent to Agricultural Extension Department for two lecturers (for five or six meetings in rural schools) one on bee-keeping and one on the problem of noxious weeds. In connection with weeds we are asking for Mr. T. Pavlychenko, an experimenter at the Research Department, who could lecture in Ukrainian and whom our local weed Inspectors would like to take out in the fields infested with weeds.
>
> (5) Series of meetings are being advertised in rural points to prepare the residents for a by-law in connection with a Pure Bred Sire Area.
>
> (6) A campaign is on foot to induce all school boards here to engage Dr. Rose to make visits to all schools to vaccinate the children. Already partly successful.
>
> The bulls that we obtained this spring are doing fine and keepers are taking good care of them. Farmers are beginning to ask for more of them, as for some of them it is quite far to take the cows. If you have any suggestions to make to our committee, I can assure you they will be greatly appreciated."

It may be objected that special preparations having been made for the visit of the judges, the community is on show for the day and that showmanship of local people may count for too much, but actually this special preparation and clean-up has results of value. The discipline of appearances is far deeper in sweep and significance than we sometimes realize,—women have been drilled into uniformity of coiffure and figure, with world-wide consequences for our food producers by just such a discipline. The well tilled field, the planned farmstead, the managed and well bred herd, the spots of beauty in a community—these can transform a landscape and they can do much to retain our people upon the soil. As a railway it is a fundamental consideration with us that our country should be attractive to the settler, as well as productive. It would have been impossible to carry out this project without the good will and co-operation of all the Departments of Agriculture, Education and Health, throughout the three Provinces. An effort has been made to direct the attention of farmers to available services of their own Government without whose direction and guidance and follow-up the results mentioned could not have been obtained.

Summarizing then, the project has included a balanced, continued programme of limited objectives within reach by voluntary effort; the use of group consciousness, whether racial, religious or cultural, stimulating local pride; the contact with outside minds of recognized tolerance and judgment; the maintenance of the spirit of self help and pioneer sense of neighborliness; the bonusing of communities that have shown a grasp of the fundamentals of community growth. The principles underlying these items will stand even if the foundations of the structure of our society, perhaps too exclusively built on the competitive basis, prove unstable. Uncomprehended change, leisure without meaning, education without culture, unparalleled technological equipment divorced from human ends,—these have produced in our urban life the malady of unemployment.

Rural life must, it is true, equip itself with every weapon in the armory of science to conquer drudgery, but the programme of this effort suggests that to be wholesome its progress should define the lines of its advance; bring some beauty and significance into the occupations of a sane leisure; support the institutions that humanize social relations, the family, the church, and the community; cultivate a respect for past achievement; and induce an attitude towards canons of taste and quality, and ideals of self help and neighborliness.

CURRENT PUBLICATIONS

THE DISTRIBUTION OF IODINE IN ALBERTA IN RELATION TO THE PREVALENCE OF GOITRE. I. Iodine in Water Supplies. By Osman James Walker, Associate Professor of Chemistry, University of Alberta. Contribution from the Department of Chemistry. Canadian Journal of Research 7:2; 137-148. August, 1932.

A preliminary study of the iodine content of the water supplies of the Province of Alberta has been made. The iodine content of the surface water is usually less than one part of iodine per billion (1000 million) parts of water. The iodine content of water from deep wells varies from 0 to 660 parts of iodine per billion parts of water. There is a relation between the iodine content of deep wells and the geological strata from which the water is derived. A goitre survey of the province is in progress and a map shows its distribution. A close relation between the iodine content of the water and the prevalence of goitre has not been revealed so far. A number of factors that may affect this relation have been discussed.

RESUME DES ARTICLES PUBLIES EN ANGLAIS DANS CE NUMERO

Effet du Milieu sur le Developpement des Maladies parasitiques et sur la Selection de Lignees resistantes a la Maladie. Par James G. Dickson, University du Wisconsin, Madison, Wis.

L'auteur fait ressortir que la plante ne peut plus être considérée uniquement en relation avec son milieu extérieur mais qu'au contraire il faut étudier avec soin l'effet du milieu sur les processus physiologiques qui se passent à l'intérieur de la plante. Des études en milieu contrôlé au laboratoire et dans la serre sont indispensables, mais doivent être complétées par des études régionales en plein air. Le problème est devenu si complexe que le biologiste, le chimiste et le physiologiste doivent coopérer pour mener à bien de pareilles études.

L'auteur cite en exemple l'effet de la température sur le réaction à la maladie de jeunes plantes de maïs et de blé. Ces deux espèces ont besoin de température différentes pour leur développement optimum. Il a été possible de produire des variétés résistantes dans un milieu favorable, mais ces mêmes variétés se montrent non résisantes quand on les place dans un milieu qui ne leur convient pas. L'auteur fait ressortir que le milieu affecte évidemment les processus génétiques, car des plantes gardées pendant trois ans dans un milieu défavorable perdent leur pouvoir de résistance à la maladie alors que des plantes provenant de la même lignée mais gardées dans un milieu favorable résistent parfaitement.

Recherches sur la Rouille de la Tige de l'Avoine au Canada. W. L. Gordon et J. N. Welsh, Laboratoire Fédéral de Recherches sur la Rouille, Winnipeg, Man.

Les auteurs résument le travail fait pour isoler les différentes variétés de rouille de la tige de l'avoine au Canada. Les différentes variétés sont classifiées et leur location indiquée. Des lignées d'une bonne productivité moyenne de certaines variétés d'avoine ont été produites qui résistent à environ 98% de toutes les formes physiologiques de rouille isolée au Canada pendant la période 1925-1930.

La Farine de Poisson pour la Nourriture des Poussins. V. S. Asmundson et Jacob Biely, Université de la Colombie Britannique, Vancouver, B.C.

Les auteurs rapportent les résultats de cinq expériences sur la croissance de poussins nourris jusqu'à 8 semaines en éleveuse artificielle avec une ration alimentaire à laquelle on a ajouté de la sardine, du saumon, du flétan, du lait écrémé en poudre, ou un mélange de saumon et de lait écrémé. Les poids moyens à 8 semaines des poussins recevant les divers suppléments ont été comme suit:—flétan—585.6 gs., sardine—636.9 gs., saumon—632.0 gs., lait écréme en poudre—648.2 gs. Le mélange de lait et de saumon a donné de meilleurs résultats que l'un ou l'autre employé seul lorsqu'on l'a utilisé pour fournir de 7.5 à 10% des protéines.

Le Service de Pulverisation des Vergers dans Quebec. Fernand L. Godbout et J. G. Coulson, Ministère de l'Agriculture, Québec, P.Q.

Les auteurs décrivent ce service tel qu'il existe dans la Province de Québec.

Le Service de Pulvérisation des Vergers dans l'Ontario. J. E. Howitt, Collège d'Agriculture de l'Ontario, Guelph, Ont.

L'auteur décrit ce service tel qu'il existe dans la Province de l'Ontario.

Nouvelle Maladie des Pommes Gravenstein. Par J. F. Hockey, Laboratoire Fédéral de Pathologie végétale, Kentville, N.S.

L'auteur décrit une nouvelle maladie des pommes ressemblant à l'échaudage. Les fruits étaient d'apparence normale et saines lors de l'envoi et lors de l'arrivée à destination, mais après une journée d'exposition à l'étalage des magasins les fruits étaient couverts de taches et invendables. Une étude a été faite de la teneur des cellules en amidon et en sucre et de l'effet de la ventilation, de la température et de la lumière. Il n'a pas été possible d'assigner une cause définie à la maladie. Elle ressemble aux dommages causés par le gaz sulfureux mais une analyse de la pelure des fruits n'a pas donné de réaction positive pour le soufre. Il est possible cependant qu'il y ait du soufre présent sous une forme ou sous une autre.

Utilisation en Vue du Progres agricole du Sentiment collectif de differents Groupes ethniques. Robert England, Chemins de Fer Canadiens Nationaux, Winnipeg, Man.

Au cours d'une conférence faite au congrès annuel de la C.S.T.A. à Winnipeg en juin dernier, l'auteur a décrit le travail fait par les Chemins de Fer Canadiens Nationaux en établissant des concours civiques entre les différents groupes ethniques d'origine européenne. Des points sont donnés aux différents groupes sur la base suivante:—A. Education: 275 points; B. Développement agricole: 275 points; C. Développement civique: 300 points; D. Economie domestique, Industries et Arts ruraux: 150 points. L'intérêt manifesté dans ces concours et été grand. L'argent reçu en prix par les différents groupes a généralement été consacré à des améliorations civiques locales.

RECENTES REUNIONS DE LA C.S.T.A.

Au cours du mois de novembre plusieurs réunions importantes de la C.S.T.A. ont été tenues en différents endroits. Au début du mois, la section de Montréal-ville organisa une soirée à laquelle assista le Dr. Barton, nouveau député-ministre de l'Agriculture à Ottawa puis la section de Montréal-district donna un déjeuner officiel en l'honneur du Dr. Barton. Enfin, dans les Cantons de l'Est, à Sherbrooke, une importante réunion tenue à l'occasion de la foire annuelle fut honorée de la présence de l'Honorable M. Godbout, Ministre de l'Agriculture à Québec.

Nous ne pourrions passer sous silence le banquet annuel donné sous les auspices de la C.S.T.A. et de l'Association des Anciens Elèves de l'O.A.C. a Guelph, banquet qui se tient toujours à l'époque de l'Exposition Agricole Royale d'Hiver à Toronto. Plus de 150 convives assistèrent au banquet tenu dans la Salle Vénétienne de l'Hotel Royal York. L'hôte d'honneur fut encore le Dr. Barton. Le discours principal fut celui de l'Hon. Manning Doherty, ancien Ministre de l'Agriculture de l'Ontario. M. Doherty exposa avec force la nécessité d'envisager l'avenir intelligemment, sans se laisser attirer aveuglément par les extrêmes politiques ou économiques, mais aussi en étant prêt s'il le faut à abandonner certains de nos préjugés parmi les plus solidement ancrés si leur examen critique montre qu'ils gênent notre développement normal et sain.

Nous signalerons également que pour la quatrième fois le grand championnat des boeufs à l'Exposition Royale d'Hiver a été gagné par L'Université de l'Alberta. Notre ancien président, le professeur Sackville, est largement responsable de ce succès, et nous l'en félicitons bien vivement.

La section de Toronto tient un déjeuner hebdomadaire le vendredi. Tous les membres de la C.S.T.A. sont cordialement invités à assister à ce déjeuner lorsqu'ils seront de passage dans la capitale de l'Ontario le vendredi.

H. E. L.

CURRENT PUBLICATIONS

PRACTICAL METHODS IN TEACHING VOCATIONAL AGRICULTURE

H. E. Lattig. Published by the McGraw-Hill Book Co., New York. Price $2.50.

During recent years there has been considerable discussion on how best to teach vocational agriculture. The subject itself covers such a wide and varied field that it could hardly be expected that all teachers would agree on the best method of procedure in building up a course of study that would adequately cover the field. However, the teacher on the job must get results, and out of the maze of conflicting theories and methods that have been advanced during recent years some general principles that can be said to be absolutely necessary for the successful teaching of this subject seem to have evolved.

A great many text books that have been published have erred in dealing too much in generalities. The new teacher has found very little in them that would help in actually putting across to his class the lesson or project. In too many cases the teaching methods have been of the same nature. It is so easy to get lost in generalities when teaching agriculture and, to the extent to which this happens, the effectiveness of the teaching is lost. Here then might be given one of the first principles in teaching agriculture—Have a definite line of procedure and a carefully planned method mapped out that really leads and lands somewhere before ever starting to teach. Perhaps the greatest compliment that can be paid to Prof. Lattig's book is that at last a work has been produced that gets down to concrete cases and outlines definite procedures and projects that a teacher can use in his everyday teaching. Step by step in a logical manner, the author has built up his material so that the teacher can grasp the essentials with little effort and can use the text as a guide in carrying the work through from beginning to end.

Again, methods must be applicable to actual farm conditions. Beautiful theories can be built up in dealing with agriculture, but unless a theory can be given a practical application in the every day farm operations, it has no place in the teaching of agriculture. Practical farmers are quick to note what is being taught their sons and daughters, and nothing so prejudices them against scientific agriculture as theories that have no practical application. It is essential to have the respect and co-operation of the parents in order that the student may get the desired encouragement from home in his or her work. The author seems to recognize this and so "Let's be practical" seems to be the key note of the book. Every project outlined, every method described is such as can be put in practice on the average farm.

Another principle that cannot be questioned, is that the project method if properly planned and directed is the most effective method of teaching agriculture. For example, a lot of facts and figures handed out on the cost of producing a dozen eggs means very little to a student, and the methods of arriving at it are soon forgotten. On the other hand, a definite project whereby the student compiles the data from his or her work with a pen of laying hens, drives the lesson home in a way that it will be remembered. Again, student interest is essential to the successful teaching of agriculture, and in no other way, in my experience, can this be so effectively secured as by a definitely and carefully planned project carried out entirely by the student. The author has made the most of project work in this book. It is a veritable gold mine of information on agricultural projects. Project after project is outlined in sufficient detail to be a joy to the teacher's heart, and they are also of such a nature that they are bound to make the desired student appeal.

In general it may be said that Prof. Lattig has made a real contribution to the successful teaching of vocational agricultural and his book should meet a long felt need on the part of teachers for a text that stresses methods rather than theories.

—E. P. Bradt.

FERMENTATION AND CRYSTALLIZATION OF HONEY. Elton J. Dyce, Ontario Agricultural College, Guelph, Canada. Published by the Cornell University Agricultural Experiment Station, Ithaca, New York. Bulletin 528.

The inadequate control of fermentation and crystallization of honey has been a serious handicap in marketing honey. The only suitable method of controlling fermentation now in use is to heat honey sufficiently to destroy the yeasts. Beekeepers and packers commonly heat their honey to excess, not only to destroy yeasts but to delay later formation of coarse crystals until the honey is consumed. Excessive heating drives off aroma, may break down sugars, and causes the honey to be lowered in quality and darkened in color.

In the process developed by Dr. Dyce, a small amount of finely crystallized honey is added to liquid honey which has been heated and the whole crystallized as rapidly as possible at a temperature of about 57°F. After granulation has occurred in from two to four days the honey may be kept at ordinary room temperature without fear of fermentation or liquification. The fine crystals formed improve the palatability and marketability of the product.

An interesting feature of this piece of work is that patents have been applied for in the name of Cornell University for the U.S.A. and the Ontario Agricultural College for Canada. It is not the intention of these institutions to hold a monopoly on the process, but rather to prevent any one else from patenting it and thus securing a monopoly.

VEGETATIVE PROPAGATION OF WILD OATS, *AVENA FATUA*, AND OTHER ECONOMICALLY IMPORTANT SPECIES OF *AVENEAE* AND *HORDEAE*. By L. E. Kirk, Dominion Agrostologist, Central Experimental Farm, Ottawa, and T. K. Pavlychenko, Assistant in Weed Research, University of Saskatchewan, Saskatoon. Contribution from the Department of Field Husbandry, University of Saskatchewan, with financial assistance from the National Research Council of Canada. Canadian Journal of Research 7:2; 204-220. August, 1932.

Following the discovery that small sections of wild oats seedlings could become rerooted and develop into normal plants, a study was undertaken to determine from what part or parts of the seedlings new growth can originate, and whether cultivated oats, wheat, barley and spring rye, would behave in a similar manner. Special attention was given to the problem of vegetative propagation in wild oats as a factor in the control of this weed.

Small sections of wild oats seedlings, one inch in length and containing the coleoptile node, became rerooted under favourable conditions and produced fully developed plants. Cultivated oats behaved in a similar manner to wild oats in this respect, but the latter produced the more vigorous growth.

When land is infested with wild oats and is plowed shallow, or cultivated shortly after the seedlings have emerged from the soil, a considerable proportion of them, under certain conditions, may produce new plants by vegetative re-growth. The extent to which this may may occur in the field depends largely on the soil moisture as well as on other conditions which facilitate rerooting, such as shallow plowing, and packing when conditions for plant growth are favourable.

CONCERNING THE C.S.T.A.

C.S.T.A. CONVENTION FOR 1933 IN REGINA

At a meeting of the Directors of the C.S.T.A. in Toronto, November eighteenth, it was decided to accept the invitation of the South Saskatchewan Branch of the C.S.T.A. to hold the annual convention of the Society in Regina at the time of the World's Grain Exhibition and Conference, July twenty-fourth to August fifth. This invitation was heartily seconded by officials of the Grain Exhibition and accompanied by an invitation from officials of Regina College to make that institution the Society headquarters during the show. This guarantees accommodation in the city of Regina for members of the Society at the same rates as those of the 1932 conference in the University of Manitoba at Winnipeg. Officials of the C.S.T.A. and representatives of affiliated groups have been made members of the Programme Committee of the World's Grain Exhibition and steps will be taken at once to synchronize programmes.

Members who are planning next year's vacation trip sould consider Regina. Special railroad and boat rates will be available. Side trips to points of interest including a week-end trip to the University of Saskatchewan are being arranged. The Grain Show itself promises to be an outstanding event. The decorations of the building and the arrangements for placing exhibits are already in an advanced stage and space is well taken. The building itself is said to be the best in Canada for such purposes. Regina Exhibition will also be in full swing during the Grain Show.

C.S.T.A.—O.A.C. BANQUET AT ROYAL FAIR

The annual C.S.T.A.-Ontario O.A.C. Alumni Association banquet was held at the Royal York Hotel, Toronto, on Friday evening, November the eighteenth. Hon. Manning Doherty, former Minister of Agriculture for Ontario, was the guest speaker and Dr. H. Barton, Deputy Minister of Agriculture for Canada, was guest of honour. Over one hundred and fifty members attended and enjoyed the excellent programme prepared by the Toronto locals of both associations.

Hon. Mr. Doherty, in a thoughtful address entitled, "Where do we go from here?" emphasized the lack of constructive planning evidenced in business circles during the past few years and took the stand that there must be control of industry either from without or within, preferably from within. Chronic unemployment faces us due to the rapid development of machinery. He quoted extensively from the recent article in the *New Outlook,* Alfred E. Smith's monthly, giving the findings of a group of well known engineers calling themselves the Technocrats. The situation may be summed up in the statement that there is not room enough for half the 14,000,000 unemployed in industry if all the factories of the United States were now running at 1929 production rates, so rapid has been technical improvement. Mr. Doherty felt that we would find a way out through epoch-making changes in our industrial structure, and that this way would be along orderly lines in a modified capitalistic system.

Brief remarks were made by other guests at the head table. Dr. G. I. Christie, President of the O.A.C. and the C.S.T.A., performed the duties of Chairman most happily. Dr. Barton was given a rousing welcome and expressed his appreciation briefly. As he is recovering from having his tonsils removed he promised the major part of his speech at a later date. Dr. Klinck, President of the University of British Columbia, was in a reminiscent mood and lightened the programme with some

excellent stories of early O.A.C. days. Perhaps his most appreciated story was an account of the old debates when one of the favourite subjects was the liquor problem, and one of the classic arguments in favour of prohibition ran something like this: "I once knew a man who owned the best threshing route in Puslinch. He took to drink, and now he is in British Columbia!" Listening to Mr. Doherty's remarks concerning captains of industry, and looking around at present conditions, one is about forced to conclude that reasoning power does not as a rule develop much beyond the peaks it reaches in early college days.

FOR ADMINISTRATION AND EXTENSION MEN

For some time the Managing Editor has been trying to increase the amount of material in *Scientific Agriculture* which might be of interest to administration and extension men without at the same time departing too far from that standard which characterizes the papers of interest to the research men. While some papers of general interest have appeared during the past year, there is seldom more than one in any one issue of the journal. Due to the fact that these have been quite frequently overlooked by the men who should read them, we feel constrained to call attention to several items in this issue lest they also be laid aside too hastily.

Senior administration officers should study the article by Dr. Dickson of Wisconsin in which he points to the need of co-operation between various branches of science in the solution of the problems of disease resistance in plants. Happily, there are indications that we are moving toward that co-ordination which Dr. Dickson advocates.

In two articles by Prof. J. E. Howitt, and Mr. F. L. Godbout and Prof. J. G. Coulson, the apple orchard spray service methods of Ontario and Quebec are described. The economy and effectiveness of this type of agricultural extension work cannot be doubted, and further improvements in these services should be effected as rapidly as possible.

Checking over the twelve volumes of *Scientific Agriculture* published to date one finds little regarding immigration and colonization. Robert England, of the Canadian National Railways, Winnipeg, tells us what is being done to naturalize the European born immigrant in the Prairie Provinces. This work is proceeding on sound psychological principles, the application of which could be made to many communities of native born Canadians. An excellent article on "Europe in Western Canada" by Mr. England appeared in the July, 1932, issue of the *Canadian Geographical Journal.*

For good measure we give a book review by E. P. Bradt of the Boys' Training School at Bowmanville, Ontario. In the review of Lattig's "Practical Methods in Teaching Vocational Agriculture", his comments on the subject are pointed, and suggest that Mr. Bradt himself should be able at some time to publish a contribution on this widely neglected field.

Next month we expect to present an article on Empire trade that is the best commentary we have yet seen on the recent Imperial Conference.

WORK OF THE C.S.T.A. COMMITTEE ON RESEARCH

The Chairman of the C.S.T.A. Committee on Research attended the meeting of the National Research Council Associate Committee on Agriculture, held in Toronto on Nov. 21st, 1932, and made the following statement on behalf of the Society:

"With the problem of research in agriculture forming the subject of a special conference, a statement regarding the work of the C.S.T.A. Committee on Research appears to be called for.

"1. This Committee is constituted as follows:

(a) A chairman elected "at large".

(b) A supporting committee, consisting of one member elected by and representative of each affiliated society or group, who is responsible for the report of his particular section.

"2. The Report of the Committee is made up as follows:

(a) Abstracts giving the nature and scope of the research work undertaken by each worker.

(b) An evaluation of the present status of each field of research, as gleaned from the reports sent in to each committee member by the workers in the field.

(c) An outline of the trends observable in each field of work.

(d) A statement of the needs and opportunities presented by each field of activity.

"In the past this committee has had no funds for carrying on any definite line of work. Scattered over the Dominion, its members have had no opportunity to consult together. For long it has been realized that there was much that might be done in developing a better method of selecting problems to be attacked, in deciding who should attempt them and in assuring the continuity of the proposed work, but the Committee have not had the means of making their recommendations effective, nor even of ensuring their consideration by those in authority. It has become increasingly difficult to persuade busy research workers to take part in committee work, when all schemes for the classification and allotment of research projects inevitably come to nought.

"The formation of this Committee of the National Research Council and of the National Advisory Committee on Agricultural Services, offers the only prospect of giving effect to the combined thought of the agricultural research workers of Canada. The Committee on Research of the C.S.T.A. believes that the work that it has undertaken is of value and that it is in the best position to secure the information desired. The members would not care, however, to go ahead with the very considerable labour involved, without the endorsation of this body. An example of the type of information the Committee is securing is before you and while the members of the Committee do not think that their labours should cease with the mere securing of this information, without evaluation or analysis, they feel that this effort represents the necessary first step."

The Associate Committee on Agriculture formally endorsed the type of work being carried on by the C.S.T.A. Committee on Research, requested that it be continued along the same lines, and promised the support of the individual members in securing the information desired.

Since the proper functioning of this Committee is peculiarly dependent upon the co-operation of the individual members of the affiliated societies and groups, it is to be hoped that a prompt response will be made to the requests of the group chairman.

W. H. Brittain, Chairman,
CS.T.A. Committee on Research.

NOTES AND NEWS

John M. Armstrong (Saskatchewan '29) has changed his address to 3590 St. Famille, Montreal, P.Q.

Chas. A. Eaves (Macdonald '32) who is at present on the staff of the Horticultural Division, Central Experimental Farm, Ottawa, has been awarded an overseas post-graduate scholarship by the Imperial Order of Daughters of the Empire. Mr. Eaves will proceed next summer to Cambridge to study cold storage at the Low Temperature Research Station, Cambridge University. The value of the scholarship is $1600.

Justus Miller, formerly Agricultural Representative for the County of Essex, Ontario, and lately Secretary of the Border City Chamber of Commerce, passed away on November 22nd after an illness of a few weeks.

N. J. Atkinson, formerly a member of the staff of the Dominion Entomological Branch and lately Biologist to the Lucerne-in-Quebec Community Association, died on November 2nd from an accidental gun shot wound received at Montebello, P.Q.

F. E. Buck (McGill '11) recently Associate Professor of Horticulture, University of British Columbia, Vancouver, is now engaged in commercial bulb growing and the supplying of spring flowering plants. He is located at Vancouver.

H. R. Hare (Toronto '14) formerly Assistant Professor of Animal Husbandry, University of British Columbia, Vancouver, is now engaged in developing a co-operative marketing programme for the dairymen of the Lower Fraser Valley of British Columbia.

W. G. Marritt (Toronto '17) Agricultural Representative for the County of Wentworth, is on leave of absence for six months to carry on organizing work for the dairy farmers of Ontario.

NEW MEMBERS

The following applications for regular membership have been received since March 1, 1932:

E. L. Gray, (Toronto 1923, B.S.A.) Edmonton, Alta.
L. V. P. Johnson, (Alberta 1931), B.S.A.) Edmonton, Alta.
Allan Deakin, (McGill 1928, B.S.A.) Ottawa, Ont.
C. A. Weir, (Manitoba 1917, B.S.A.) Calgary, Alta.
W. L. Carlyle, (Toronto 1892, B.S.A.) High River, Alta.
W. S. Benson, (Saskatchewan 1921, B.S.A.) Calgary, Alta.
A. Fillion, (Laval 1931, B.S.A.) Richmond, P.Q.
R. H. Carlyle, (Alberta 1931, B.Sc.) Manyberries, Alta.
G. L. Shanks, (Iowa 1931, M.S.) Winnipeg, Man.
R. C. Moffat, (Toronto 1916, M.A.) Guelph, Ont.
D. E. MacPhee, (Toronto 1931, B.Sc.) Canso, N.S.
W. F. Geddes, (Toronto 1918, B.S.A.) Winnipeg, Man.
H. J. Kemp, (Manitoba 1923, B.S.A.) Swift Current, Sask.
Robert Ward, (Acadia 1932, B.Sc.) Kentville, N.S.
Wilson Henderson, (British Columbia 1932, B.S.A.) Sardis, B.C.
Fred Gfeller, (Toronto 1932, B.S.A.) Ottawa, Ont.
Gerard Lemire, (Laval 1931, B.S.A.) L'Isle Verte, P.Q.
J. E. Dube, (Laval 1931, B.A.) Rimouski, P.Q.
Maurice St. Pierre, (Laval 1931, B.A.) Quebec, P.Q.
W. Chamberland, (Laval 1931, B.A.) Gaspe, P.Q.
L. J. St. Yves, (Laval 1931, B.Sc.) Beauceville, P.Q.
J. S. McGowan, (Manitoba 1924, B.S.A.) Montreal, P.Q.
J. W. Hopkins, Sr., University of Alberta, Edmonton.